WORK BOOK

TO

A NEW CERTIFICATE CHEMISTRY

PARESH SAXENA
&
V. P. SAXENA

PITAMBAR PUBLISHING COMPANY

Based on the latest Syllabus in Chemistry for I.C.S.E. Examination (Classes IX & X)

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TO

A NEW CERTIFICATE CHEMISTRY

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PREFACE

Workbook to 'A New Certificate Chemistry' contains both short-answer type questions and objective type questions of various types. These questions have been constructed and arranged to serve the following objectives :

1. To reinforce learning experiences through intelligent recall of pertinent facts and their expression in writing.

2. To help students develop the indispensable ability of answering questions in a concise and precise manner.

3. To enable students to assess the factual knowledge of various topics as also the higher abilities of critical thinking and reasoning.

4. To help students identify the specific areas in which the right level of understanding has not been reached.

5. To guide the course of study during revisions.

Answers to questions have been provided. These answers should be made use of only for comparison after the student has written out his own answers.

The authors earnestly hope that by using this workbook in a proper manner the students will acquire a firm grasp of the subject and develop an intelligent interest in its study.

Any suggestions for the improvement of the workbook will be gratefully acknowledged and incorporated in the subsequent editions.

Paresh Saxena
Ved Prakash Saxena

CONTENTS

1

States of Matter

1. What are the two attributes of matter ? ....

....

2. Define 'material' and give two examples. ....

....

3. What is a homogeneous material ? ....

....

4. What is a heterogeneous material ? ....

....

5. From the following list, select homogeneous materials and heterogeneous materials : pure sugar soil, lemonade, smoke, wood, sulphuric acid, coal, cooking gas. ....

....

....

....

6. (*a*) Name the three states of matter. ....

....

(*b*) Describe each state of matter in terms of volume and shape. ....

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....

7. Bring out the difference between 'gas' and 'vapour'. Give two examples. ....

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....

8. Write the technical term for each of the following interconversions of states of matter :

(*a*) The change from liquid to solid : ....

(*b*) The change from solid to gas : ....

(*c*) The change from liquid to gas : ....

(*d*) The change from solid to liquid : ....

(*e*) The change from gas to solid : ....

(*f*) The change from gas to liquid : ....

9. In what two ways may a gas be changed into liquid ?

(1) ....

(2) ....

10. Name four solid substances which directly change to gaseous state on heating. ....

....

11. Write the term for the solid which is formed directly from a gas. ....

12. Give the three main postulates of the kinetic theory of matter. ....

....

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13. How does the speed of the molecules change when :

(*a*) ice changes to water ? ....

(*b*) steam changes to water ? ....

(*c*) water changes to ice ? ....

(*d*) water changes to steam ? ....

14. Name the state of matter in which the molecules are (*a*) closest together, and (*b*) farthest apart.

(*a*) ....

(*b*) ....

15. Explain why a solid is rigid, hard, and shape-retaining. ....

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16. A gas fills its container completely. Explain the reason. ....

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17. Why are the gases highly compressible ? ....

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18. On the basis of the kinetic theory of matter, explain (*a*) melting : ....

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(*b*) evaporation : ....

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(*c*) condensation : ....

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(*d*) freezing : ....

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(*e*) sublimation of a solid : ....

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19. Common salt (sodium chloride) and sal-ammoniac (ammonium chloride) are both white substances. How will you distinguish between the two without tasting or using any other substance ? ....

....

....

....

....

20. As ice melts to water, which of the two properties change : structure or composition ?

....

21. Define the 'melting point' of a solid. ....

....

....

....

22. How is the melting point of a solid affected by the presence of impurities ? ....

....

23. Define the 'boiling point' of a liquid. ....

....

....

....

24. How the boiling point of a liquid affected by the presence of impurities ? ....

....

25. Against each of the following statements write 'T' if it is true and 'F' if it is false :

(1) The particles in a solid are motionless. ....

(2) The gaseous state of water is called water gas. ....

(3) Gases have no free surfaces. ....

(4) Sea water boils at a higher temperature than does distilled water. ....

(5) A solution of sugar in water is homogeneous. ....

(6) A suspension of clay in water is homogeneous. ....

(7) Matter is most compressible in the gaseous state. ....

□□

2

Physical and Chemical Changes

1. Define a 'physical change'. ....

....

2. Define a 'chemical change'. ....

....

3. Point out the differences between dissolving sodium chloride in water and dissolving sodium chloride in hot sulphuric acid. ....

....

....

....

....

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....

....

4. How is the weight of a substance affected when it undergoes :

   (*a*) a physical change ? ....

   (*b*) a chemical change ? ....

5 What are the energy changes that take place when a candle burns ? ....

....

....

....

6. Name the physical and chemical changes that occur in a burning candle. ....

....

....

7. When hydrogen burns in air, the change is classified as chemical. Give two reasons to support this. ....

....

....

8. A chemical change may be endothermic or exothermic. Distinguish between the two types of chemical change. ....

....

....

....

9. State three differences between physical change and chemical change.

Physical change	Chemical change
1.	1. ....
....	....
2.	2. ....
....	....
3.	3. ....
....	....

10. Give three reasons to establish that the burning of a candle involves a chemical change.

....

....

....

....

11. State, giving two simple reasons, whether a physical change or chemical change occurs in each of the following :

(*a*) adding sodium to water. ....change.

Reasons. ....

....

(*b*) adding sodium chloride to water. ....change.

Reasons...

....

(*c*) heating of ammonium chloride. ....change.

Reasons...

....

(*d*) heating of magnesium in air. ....change.

Reasons. ....

....

(*e*) freezing of water. ....change.

Reasons. ....

....

(*f*) milk turning sour. ....change.

Reasons. ....

....

(*g*) rusting of iron. ....change.

Reasons. ....

....

(*h*) passing carban dioxide in water. ....change.

Reasons. ....

....

(*i*) passing direct current through acidulated water. ....change.

Reasons. ....

....

12. There are several types of chemical reactions, e.g., reactions of decomposition, reactions of combination, etc. Against each of the reactions given below, write down the type of

reaction it is :

(*a*) Liberation of hydrogen from zinc and dilute acid. ....

....

(*b*) Liberation of carbon dioxide by the action of heat on calcium carbonate. ....

....

(*c*) Formation of silver chloride on mixing solutions of sodium chloride and silver nitrate.

....

(*d*) Burning of carbon in oxygen to form carbon dioxide. ....

....

(*e*) Formation of sodium chloride from sodium hydroxide and hydrochloric acid.

....

(*f*) Formation of sodium chloride by burning sodium in chlorine. ....

....

(*g*) Fomation of sodium chloride by heating sodium in dry hydrogen chloride.

....

13. Write two equations for each of the following :

(1) Reaction of combination. ....

....

(2) Reaction of decomposition. ....

....

(3) Reaction of displacement. ....

....

(4) Reaction of double decomposition. ....

....

14. (*a*) What is a photochemical reaction ? ....

....

(*b*) Give one example of a photochemical reaction. ....

....

15. Define the term 'catalyst'. ....

....

16. (*a*) Give one example of a chemical reaction in which a catalyst is used. ....

....

(*b*) Write down the chemical equation for the reaction given in 16 (*a*).

....

17. (*a*) What is meant by the term 'properties' of a substance ? ....

....

....

(*b*) What are the two main groups of the properties of substances ? ....

....

(*c*) List three important properties of each of the two groups of properties of substances.

....

....

18. Mention four physical properties of water which are altered by adding common salt to it. Also write for each property in what way it is altered. ....

....

....

....

19. Name three physical constants of substances. ....

....

20. Select the correct word in the following statements :

(1) A physical change is (temporary/permanent).

(2) A chemical change (can be/cannot be) easily reversed.

(3) A (physical/chemical) change causes a change in the composition of the substance.

(4) A physical change may cause a change in the (structure/composition) of the substance.

(5) Burning of coal involves an (endothermic/exothermic) chemical reaction.

(6) Decomposition of mercuric oxide into mercury and oxygen upon heating is an (endothermic/exothermic) chemical change.

(7) The substances that undergo a chemical change are called (reactants/products).

(8) The equation $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$ represents a reaction of (addition/displacement).

(9) A photochemical reaction takes place by the action of (heat/light) energy.

(10) A solid formed by a reaction occuring in solutions is called a (precipitate/residue).

(11) Sulphur dioxide combines with oxygen to give sulphur dioxide in the presence of platinum. In this reaction platinum is a (reactant/catalyst).

(12) Solubility of a substance is a (physical/chemical) property.

3

Elements, Compounds, and Mixtures

1. List three characteristics of a pure substance. ....

....

2. 'Oxygen is an element'. What information about oxygen is conveyed by this statement ?

....

....

3. Write chemical formulae of (*a*) three monatomic molecules and (*b*) three diatomic molecules. (*a*) Monatomic molecules : ....

(*b*) Diatomic molecules : ....

4. Give three differentiating properties of metals and non-metals.

Metals	*Non-metals*
1.	1. ....
....	....
2.	2. ....
....	....
3.	3. ....
....	....

5. What are metalloids ? Give two examples. ....

....

....

....

6. Define the term 'compound'. ....

....

....

7. Hydrogen is a gas that burns in oxygen and oxygen supports the combustion of burning substances. Yet, water—a compound of hydrogen and oxygen—does not burn and extinguishes burning substances. Explain. ....

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8. 'A compound always has a fixed composition.' Explain the statement with a suitable example. ....

....

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....

....

9. Give one-word term for : (*a*) The separation of a compound into its elements by chemical means. ....

(*b*) The formation of a compound by the union of its elements or simpler compounds.

....

10. Give two examples each of (*a*) homogeneous mixtures : ....

....

(*b*) heterogeneous mixtures. ....

....

11. What is an alloy ? Give one example. ....

....

12. Give five differences between chemical compounds and mixtures.

	Compounds	*Mixtures*
1.	....	....
2.	....	....
3.	....	....
	....	....
4.	....	....
	....	....
5.	....	....
	....	....

13. (*a*) Describe what happens when a mixture of iron filings and sulphur is heated. ....

....

....

....

(*b*) Write the name and the formula of the substance. ....

(*c*) Is the reaction taking place under 13 (*a*) endothermic or exothermic ? ....

....

(*d*) Give reason to support your answer to 13 (*c*). ....

....

....

....

14. In what respects is the iron-sulphur mixture different from iron sulphide ? ....

....

....

....

....

....

....

....

15. What differences are observed when (*a*) powdered iron sulphide and (*b*) a mixture of powdered iron and sulphur are (*i*) shaken separating in a test tube of water....................

....

....

and (*ii*) shaken separately in a test tube of carbon disulphide ? ....

....

....

....

16. Describe the action of dilute hydrochloric acid on (*a*) iron sulphide ....

....

....

....

and (*b*) a mixture of iron and sulphur. ....

....

....

....

17. Give three reasons, in each case, why you consider that (*a*) water is a compound............

....

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....

....

(*b*) air is a mixture. ....

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18. When molten copper and zinc are mixed together and cooled, a homogeneous metallic solid called brass is obtained. However brass is not regarded as a compound Explain the reasons. ....

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....

19. Elements A and B were mixed together and finely powdered. When the mixture was added to dilute sulphuric acid, A dissolved with the evolution of a gas that burned with a 'pop' ; B was left behind as yellow particles. When the original mixture was heated, a greyish hard solid (X) was formed. X dissolved in dilute sulphuric acid giving off a gas (Y) with the smell rotten eggs. The resulting solution (S) on treatment with sodium hydroxide solution gave a dirty green precipitate (Z).

(*a*) Identify the substances A, B, X, Y, S, and Z.

A is ....B is...

X is ....Y is...

S is ....Z is...

(*b*) Write equations for the following reactions :

(*i*) Reaction between A and dil. H_2SO_4. ....

(*ii*) Reaction between A and B. ....

(*iii*) Reaction between X and dil H_2SO_4. ....

(*iv*) Reaction between S and NaOH soln. ....

(*c*) Mention the type of each reaction under 17 (*b*).

(*i*) ....

(*ii*) ....

(*iii*) ....

(*iv*) ....

20. Which property of sulphur can be used for its separation from a sulphur iron-mixture ?

....

21. Classify the following as element, compound or mixture, giving reasons in each case :

(*a*) sea-water ....

....

(*b*) sodium chloride ....

....

(*c*) iron ....

....

(*d*) producer gas ....

....

(*e*) distilled water ....

....

22. Indicate briefly the methods for the separation of the following mixtures:

(*i*) sodium chloride and water ....

(*ii*) water and mustard oil ....

(*iii*) sodium chloride and iodine ....

(*iv*) powdered chalk and water ....

(*v*) components of colouring matter in ink ....

(*vi*) Alcohol (b.p. 78°C) and water (b.p. 100°C) ....

23. Describe briefly the basis of chromatography. ....

....

....

....

24. Name the process used for each one of the following :

(*i*) Obtaining petrol from crude oil. ....

(*ii*) Obtaining salt from sea water. ....

(*iii*) Obtaining drinking water from sea water. ....

(*iv*) Obtaining silver chloride precipitated from a solution of a silver nitrate upon addition of hydrochloric acid. ....

25. Describe in brief how you would separate sulphur, potassium nitrate, and carbon from a mixture of these substances. ....

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26. Against each of the following statements write 'T' if it is true and 'F' if it is false :

(*i*) The composition of a pure substance is fixed. ....

(*ii*) A pure substance may be homogeneous or heterogeneous. ....

(*iii*) Mixtures are always heterogenous. ....

(*iv*) An element cannot be formed from simpler substances. ....

(*v*) Most of the elements are solids under ordinary conditions. ....

(*vi*) Two elements can combine to form only one single compound. ....

(*vii*) The constituents of a compound can be separate by mechanical means. ....

(*viii*) A mixture has no characteristic properties of its own. ....

(*ix*) A mixture of two immiscible liquids is best separated by fractional distillation. ......

(*x*) A mixture of iodine and sand can be separated by sublimation. ....

☐☐

4

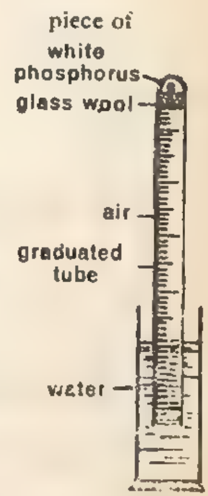
Air and Burning

1. Name the two main gases present in air, and the approximate proportion by volume of each one. ....

....

2. Name two gaseous substances (other than oxygen, nitrogen, and inert gases) present in air. ....

3. The diagram in the margin illustrates a method of finding out the fraction of air used up in burning of phosphorus.



(*a*) Name the gas left behind after phosphorus no longer burns.

....

(*b*) How will the level of water inside the graduated tube change ?

....

(*c*) When does the phosphorus cease to burn. ....

....

(*d*) Name the gas in air which supports burning and describe its function in the process of burning. ....

....

....

(*e*) Name the substance of the white fumes that are produced in the burning of phosphorus inside the tube. ....

4. (*a*) Name the two main substances produced when a candle burns in air. ....

....

(*b*) How are these substances formed ? ....

....

....

....

5. (*a*) Explain the observations you will make when a lighted candle set in a deflagrating spoon is lowered inside an empty gas jar and its mouth covered with a disc.

....

....

....

....

....

(*b*) What will happen if clear time-water is poured into the jar ? ....

....

6. (*a*) Define 'burning'. ....

....

....

....

(*b*) What are combustible substances ? Give three examples. ....

....

....

(*c*) What are incombustible substances ? Give three examples. ....

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7. When burnt in air, magnesium gains in weight but coal is reduced to a little ash showing loss of weight. Explain these observations. ....

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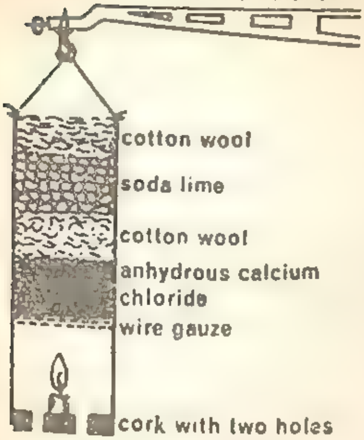

8. The diagram in the margin shows an arrangement of apparatus which can be used to show that there is an increase in weight when a candle burns.

(1) Why is a cork with holes used ?

(2) Why does the weight increase ?

(3) What is the function of soda lime ?

(4) How is soda lime made ?

(5) What is the function of anhydrous calcium chloride ?

9. (*a*) How does the process of respiration resemble the burning of candle ?

(*b*) In what respects does the process of respiration differ from the burning of candle.

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10. Compare the compositions of the respired air and inspired air. ....

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11. Outline the method of determining the percentage of oxygen in air by using alkaline pyragallol. ....

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12. Name two major constituents of air other than oxygen and nitrogen and describe how each of these can be identified. ....

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13. (*a*) Name four substances which absorb water vapour. ....

....

(*b*) Name a liquid substance used for drying such gases as oxygen and nitrogen.

....

14. (*a*) Name the inert gases present in air. ....

....

(*b*) Why are these gases called the inert gases. ....

....

15. Give *three* reasons to prove that air is a mixture and not a compound. ....

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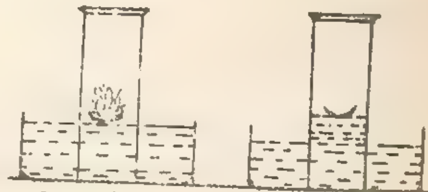
16. Explain the following observations :

(1) When a substance is burnt in air enclosed over water, the level of water rises. ....

....

....



....

(2) If a glass is held over the flame of a burning candle, a mist appears on the surface of glass. ....

....

(3) Respired air contains less of oxygen but more of carbon dioxide and water than the inspired air. ....

....

....

(4) The proportion of nitrogen in both respired air and inspired air is the same. ....

....

(5) Clear lime water turns milky on prolonged exposure to air. ....

....

....

(6) Anhydrous calcium chloride becomes sticky on exposure to air. ....

....

(7) Air dissolved in water is richer in oxygen. ....

....

(8) Gunpowder (a finely powdered mixture of potassium nitrate, carbon, and sulphur) burns without air when heated strongly enough. ....

....

5

Water

1. Explain the property of water which enables the fish in a pond to remain alive even when the pond has frozen to a considerable depth ? ....

....

....

....

....

2. How does the presence of dissolved solids affect (*a*) the boiling point, and (*b*) the freezing point of water ? ....

....

....

3. What property makes water an excellent substance to use in the cooling systems ? ....

....

....

4. Give *three* differences between freshly distilled water and ordinary tap water. ....

....

....

....

....

....

5. Briefly describe the experiment you would perform to distinguish between rain water and spring water. ....

....

6. (*a*) With the aid of a neat labelled diagram, briefly describe the experiment you would perform to show that tap-water contains dissolved solids.

(*b*) Give two differences between fresh distilled water and ordinary rain water.

7. A colourless liquid may be either pure water or a solution of common salt in water. Briefly describe three experiments which could be performed to find out which of the two it is.

8. (*a*) Define the term 'solution'.

(b) Define the terms 'solute' and 'solvent'. ....

....

....

....

(c) What is meant by a 'tincture'? ....

....

....

9. (a) Why is it not possible to separate solute from a solution by filtration? ....

....

....

....

(b) Why is a solution homogeneous? ....

....

....

10. What evidence establishes the fact that a solution is a mixture of its components, and not a compound? ....

....

....

....

11. A solution of salt in water is described as 'saturated'. What does this mean? ....

....

....

....

....

12. What is meant by an 'unsaturated solution'? ....

....

....

....

13. You are given a solution of a salt in water. How would you determine whether the solution is saturated or unsaturated ? ....

....

....

....

....

....

14. (*a*) Define the term *solubility of a solid.* ....

....

....

....

(*b*) The solubility of potassium nitrate at 45°C is 54 g. What does this statement mean ?

....

....

....

....

15. (*a*) The solubilities of some solids increase fairly rapidly as temperature rises, of others increase but only very slightly, and of some decrease with rise in temperature. Name two solids of each one of these types

Type I : ....

Type II : ....

Type III : ....

(*b*) How are the solubilities of salts most usually affected by increase of temperature ?

....

....

16. (*a*) What will you observe when a saturated solution of potassium nitrate is cooled to room temperature ? ....

....

....

(b) Explain the observation.

17. What steps would you take to increase the speed of solubility of a given solid in a liquid ?

18. Describe in about 100 words how you would experimentally determine the solubility of a solid in water at, say, 50°C.

19. What is a solubility curve and how it is plotted ? ....,

....,

....,

....,

....,

....

....

20. Mention two important pieces of information given by a 'solubility curve'. ....

....

....

....

....,

....,

21. The solubility of common salt at room temperature is given as 36 g per 100 g water. What weight of common salt should there be in 340 g of a saturated solution at room temperature ? ....

....

....

....

....,

22. Impure solids are usually purified by crystallization. Explain why the crystals depositing from a saturated solution are purer than the initial impure substance dissolved. ....

....

....

....

....

....

....

23. Give two examples each of crystalline and amorphous substances.

Crystalline : ....

Amorphous : ....

24. (*a*) Explain the meaning of *water of crystallization.* ....

(*b*) How would you obtain a sample of pure water from dry crystals of washing soda (sodium carbonate). ....

25. Blue crystals of copper sulphate having the formula $CuSO_4 \cdot 5H_2O$ are said to be hydrated. (*a*) What is meant by 'hydrated' ? (*b*) What does the dot between $CuSO_4$ and $5H_2O$ signify ? ....

26. How would you determine whether a given salt contains water of crystallization or not ? ....

27. Hydrated salts when heated in a test tube produce drops of a colourless liquid on the upper part of the test tube. How will you prove that this liquid is water ?

28. (*a*) Blue crystals of copper sulphate are heated in a test tube. Write down the observations and tne relevant inferences.

Observations :

Inferences :

(*b*) Write down the equation for the action of heat on the blue crystals of copper sulphate.

(*c*) Write down the chemical names and formulae of three hydrated salts.

29. What happens when washing soda crystals are left exposed to the air ? What name is given to this behaviour ? What is its cause ?

30. (a) With the aid of a neat labelled diagram, briefly describe how would you obtain a specimen of the air dissolved in tap water. ……………………………………………………

(b) Compare the percentages of oxygen and nitrogen by volume in the air thus obtained with those of ordinary air. ……………………………………………………

(c) Describe the biological importance of the air dissolved in water. ……………………

31. (a) How does the solubility of gases varies with change in temperature and pressure ?

(b) When a bottle of soda-water is opened, there is a 'fizz'. Explain. ……………………

32. Describe what happens when, and write equations :

(*a*) a piece of sodium is added to water :

Observations : ....

Equation : ....

(*b*) Calcium metal is dropped into cold water :

Observations : ....

Equation : ....

(*c*) Steam is passed over strongly heated magnesium :

Observations : ....

Equation : ....

33. (*a*) Under what conditions do iron and water react to produce hydrogen ? ....

....

....

(*b*) Write the name and formula of the other substance formed in the reaction.

....

(*c*) Write the equation for the reaction. ....

(*d*) Why is the reaction described as reversible ? ....

....

....

....

(*e*) How does this reaction differ from the reaction between heated magnesium and steam : ....

....

....

34. Complete the following statements :

(1) Boiled water tastes flat because ....

(2) Water has maximum density at ....

(3) Rain water does not contain dissolved ....

(4) A solution is always clear and transparent because ....

....

(5) The solution from which crystals have been deposited is called ....

(6) A substance from which water of crystallization has been completely expelled is termed ....

(7) The property of a hydrated salt losing whole or part of its water of crystallization when exposed to air is called ....

(8) Compared to ordinary air, the air dissolved in water is richer in ....

(9) When sodium has reacted with water, the resulting liquid is soapy between the fingers and turns red litmus blue. This is due to the dissolved .... produced in the reaction.

(10) When calcium has reacted with water, the resulting liquid is milky in appearance. This is due to the formation of .... which is a sparingly soluble substance.

☐☐

6

Oxygen

1. Name three substances of different kinds which evolve oxygen upon heating. In eac case give the balanced equation for the reaction.

   (1) *Name* : ....

   Equation : ....

   (2) *Name* : ....

   Equation : ....

   (3) *Name* : ....

   Equation : ....

2. Write equations for the action of heat on (1) potassium chlorate, and (2) red lead.

   (1) ....

   (2) ....

3. (*a*) Name two oxides which decompose on heating to give free metal and oxygen. Write equation for the decomposition of each oxide.

   (1) *Name* : ....

   Equation : ....

   (2) *Name* : ....

   Equation : ....

   (*b*) Name two oxides which decompose on heating to give oxygen and an oxide with less amount of oxygen. Write equation for the decomposition of each oxide.

   (1) *Name* : ....

Equation : ....

(2) *Name :* ....

Equation : ....

4. Oxygen is often prepared in the laboratory by the decomposition of hydrogen peroxide in the presence of a catalyst ?

(*a*) What is meant by a catalyst ? ....

....

....

(*b*) Which substance is used as catalyst in the decomposition of hydrogen peroxide ?

....

(*c*) Write the equation for the catalytic decomposition of hydrogen peroxide.

....

(*d*) How is the oxygen produced from hydrogen peroxide collected ?

....

(*e*) How would the rate of evolution of oxygen from hydrogen peroxide be affected if no manganese dioxide is used ? ....

....

5. (*a*) Draw a labelled diagram for the laboratory preparation of oxygen from hydrogen peroxide.

(*b*) Describe the procedure in about 40 words.

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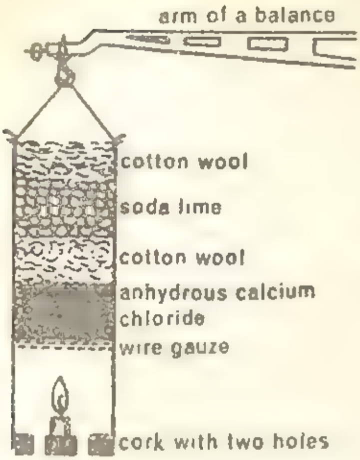
(*c*) How would you collect the oxygen evolved in a dry state. ....

....



8. The diagram in the margin shows an arrangement of apparatus which can be used to show that there is an increase in weight when a candle burns.

(1) Why is a cork with holes used ?

(2) Why does the weight increase ?

(3) What is the function of soda lime ?

(4) How is soda lime made ?

(5) What is the function of anhydrous calcium chloride ?

9. (*a*) How does the process of respiration resemble the burning of candle ?

(*b*) In what respects does the process of respiration differ from the burning of candle

10. Compare the compositions of the respired air and inspired air. ....

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11. Outline the method of determining the percentage of oxygen in air by using alkaline pyragallol. ....

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12. Name two major constituents of air other than oxygen and nitrogen and describe how each of these can be identified. ....

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13. (*a*) Name four substances which absorb water vapour. ....

....

(*b*) Name a liquid substance used for drying such gases as oxygen and nitrogen.

....

14. (*a*) Name the inert gases present in air. ....

....

(*b*) Why are these gases called the inert gases. ....

....

15. Give *three* reasons to prove that air is a mixture and not a compound. ....

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16. Explain the following observations :

(1) When a substance is burnt in air enclosed over water, the level of water rises. ....

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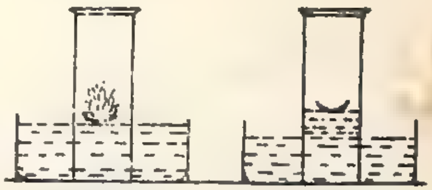

....

(2) If a glass is held over the flame of a burning candle, a mist appears on the surface of glass. ....

....

(3) Respired air contains less of oxygen but more of carbon dioxide and water than the inspired air. ....

....

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(4) The proportion of nitrogen in both respired air and inspired air is the same. ....

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(5) Clear lime water turns milky on prolonged exposure to air. ....

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....

(6) Anhydrous calcium chloride becomes sticky on exposure to air. ....

....

(7) Air dissolved in water is richer in oxygen. ....

....

(8) Gunpowder (a finely powdered mixture of potassium nitrate, carbon, and sulphur) burns without air when heated strongly enough. ....

....

5

Water

1. Explain the property of water which enables the fish in a pond to remain alive even when the pond has frozen to a considerable depth ? ....

....

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....

....

2. How does the presence of dissolved solids affect (*a*) the boiling point, and (*b*) the freezing point of water ? ....

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3. What property makes water an excellent substance to use in the cooling systems ? ....

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....

4. Give *three* differences between freshly distilled water and ordinary tap water. ....

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5. Briefly describe the experiment you would perform to distinguish between rain water and spring water. ....

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6. (*a*) With the aid of a neat labelled diagram, briefly describe the experiment you would perform to show that tap-water contains dissolved solids. ....

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....

(*b*) Give two differences between fresh distilled water and ordinary rain water. ....

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7. A colourless liquid may be either pure water or a solution of common salt in water. Briefly describe three experiments which could be performed to find out which of the two it is. ....

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8. (*a*) Define the term 'solution'. ....

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(*b*) Define the terms 'solute' and 'solvent'. ....

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(*c*) What is meant by a 'tincture' ? ....

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9. (*a*) Why is it not possible to separate solute from a solution by filtration ? ....

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(*b*) Why is a solution homogeneous ? ....

....

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10. What evidence establishes the fact that a solution is a mixture of its components, and not a compound ? ....

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11. A solution of salt in water is described as 'saturated'. What does this mean ? ....

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12. What is meant by an 'unsaturated solution' ? ....

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13. You are given a solution of a salt in water. How would you determine whether the solution is saturated or unsaturated ? ....

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14. (a) Define the term *solubility of a solid.* ....

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(b) The solubility of potassium nitrate at 45°C is 54 g. What does this statement mean ?

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15. (a) The solubilities of some solids increase fairly rapidly as temperature rises, of others increase but only very slightly, and of some decrease with rise in temperature. Name two solids of each one of these types

Type I : ....

Type II : ....

Type III : ....

(b) How are the solubilities of salts most usually affected by increase of temperature ?

....

....

16. (a) What will you observe when a saturated solution of potassium nitrate is cooled to room temperature ? ....

....

....

(b) Explain the observation.

What steps would you take to increase the speed of solubility of a given solid in a liquid ?

Describe in about 100 words how you would experimentally determine the solubility of a solid in water at, say, 50°C.

19. What is a solubility curve and how it is plotted ? ....

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20. Mention two important pieces of information given by a 'solubility curve'. ....

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21. The solubility of common salt at room temperature is given as 36 g per 100 g water. What weight of common salt should there be in 340 g of a saturated solution at room temperature ? ....

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22. Impure solids are usually purified by crystallization. Explain why the crystals depositing from a saturated solution are purer than the initial impure substance dissolved. ....

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23. Give two examples each of crystalline and amorphous substances.

Crystalline : ....

Amorphous : ....

24. (*a*) Explain the meaning of *water of crystallization.* ....

....

....

....

(*b*) How would you obtain a sample of pure water from dry crystals of washing soda (sodium carbonate). ....

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25. Blue crystals of copper sulphate having the formula $CuSO_4 \cdot 5H_2O$ are said to be hydrated. (*a*) What is meant by 'hydrated' ? (*b*) What does the dot between $CuSO_4$ and $5H_2O$ signify ? ....

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26. How would you determine whether a given salt contains water of crystallization or not ?

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27. Hydrated salts when heated in a test tube produce drops of a colourless liquid on the upper part of the test tube. How will you prove that this liquid is water ?

28. (*a*) Blue crystals of copper sulphate are heated in a test tube. Write down the observations and the relevant inferences.

Observations :

Inferences :

(*b*) Write down the equation for the action of heat on the blue crystals of copper sulphate.

(*c*) Write down the chemical names and formulae of three hydrated salts.

29. What happens when washing soda crystals are left exposed to the air ? What name is given to this behaviour ? What is its cause ?

30. (*a*) With the aid of a neat labelled diagram, briefly describe how would you obtain a specimen of the air dissolved in tap water.

(*b*) Compare the percentages of oxygen and nitrogen by volume in the air thus obtained with those of ordinary air.

(*c*) Describe the biological importance of the air dissolved in water.

31. (*a*) How does the solubility of gases varies with change in temperature and pressure ?

(*b*) When a bottle of soda-water is opened, there is a 'fizz'. Explain.

32. Describe what happens when, and write equations :

(a) a piece of sodium is added to water :

Observations :

Equation :

(b) Calcium metal is dropped into cold water :

Observations :

Equation :

(c) Steam is passed over strongly heated magnesium :

Observations :

Equation :

33. (*a*) Under what conditions do iron and water react to produce hydrogen ? ....

....

....

(*b*) Write the name and formula of the other substance formed in the reaction.

....

(*c*) Write the equation for the reaction. ....

(*d*) Why is the reaction described as reversible ? ....

....

....

....

(*e*) How does this reaction differ from the reaction between heated magnesium and steam : ....

....

....

34. Complete the following statements :

(1) Boiled water tastes flat because ....

(2) Water has maximum density at ....

(3) Rain water does not contain dissolved ....

(4) A solution is always clear and transparent because ....

....

(5) The solution from which crystals have been deposited is called ....

(6) A substance from which water of crystallization has been completely expelled is termed ....

(7) The property of a hydrated salt losing whole or part of its water of crystallization when exposed to air is called ....

(8) Compared to ordinary air, the air dissolved in water is richer in ....

(9) When sodium has reacted with water, the resulting liquid is soapy between the fingers and turns red litmus blue. This is due to the dissolved .... produced in the reaction.

(10) When calcium has reacted with water, the resulting liquid is milky in appearance. This is due to the formation of .... which is a sparingly soluble substance.

☐☐

6

Oxygen

1. Name three substances of different kinds which evolve oxygen upon heating. In each case give the balanced equation for the reaction.

   (1) *Name* : ....

   Equation : ....

   (2) *Name* : ....

   Equation : ....

   (3) *Name* : ....

   Equation : ....

2. Write equations for the action of heat on (1) potassium chlorate, and (2) red lead.

   (1) ....

   (2) ....

3. (*a*) Name two oxides which decompose on heating to give free metal and oxygen. Write equation for the decomposition of each oxide.

   (1) *Name* : ....

   Equation : ....

   (2) *Name* : ....

   Equation : ....

   (*b*) Name two oxides which decompose on heating to give oxygen and an oxide with less amount of oxygen. Write equation for the decomposition of each oxide.

   (1) *Name* : ....

Equation : ....

(2) *Name* : ....

Equation : ....

4. Oxygen is often prepared in the laboratory by the decomposition of hydrogen peroxide in the presence of a catalyst ?

(*a*) What is meant by a catalyst ? ....

....

....

(*b*) Which substance is used as catalyst in the decomposition of hydrogen peroxide ?

....

(*c*) Write the equation for the catalytic decomposition of hydrogen peroxide.

....

(*d*) How is the oxygen produced from hydrogen peroxide collected ?

....

(*e*) How would the rate of evolution of oxygen from hydrogen peroxide be affected if no manganese dioxide is used ? ....

....

5. (*a*) Draw a labelled diagram for the laboratory preparation of oxygen from hydrogen peroxide.

(*b*) Describe the procedure in about 40 words.

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....

(*c*) How would you collect the oxygen evolved in a dry state. ....

....

8

Atomic Structure and Chemical Bonding

1. (*a*) Atoms are made up of the fundamental particles protons, electrons, and neutrons. Give the mass and charge of each one of these particles.

   (*i*) Proton : ....

   (*ii*) Electron : ....

   (*iii*) Neutron : ....

   (*b*) Where are these particles located in the atom ? ....

   ....

   ....

   ....

2. What is atomic mass unit (a.m.u.) ? ....

   ....

   ....

   ....

3. Proton is positively charged and electron negatively charged. Atoms contain both protons and neutrons; yet, they are electrically neutral. Explain. ....

   ....

   ....

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   ....

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   ....

4. (*a*) Define the terms : (1) Atomic number, and (2) Mass number.

1. ....

....

2. ....

....

(*b*) How does the mass number of an atom differs from the atomic weight ? ....

....

....

5. What information is conveyed by the following statements :

(*a*) The atomic number of magnesium is 12. ....

....

....

(*b*) The mass number of magnesium is 24. ....

....

....

6. The atom of an element is made up of 4 protons, 5 neutrons, and 4 electrons. Write its atomic member and mass number.

(1) Atomic number =.......................... (2) Mass number =..........................

7. (*a*) What is an electron orbit ? ....

....

(*b*) How are electron orbits (or, shells) designated ? ....

....

....

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(*c*) Why are electron orbits also called energy levels ! ....

....

....

(*d*) How do the energies of electrons in various orbits in an atom vary ? ....

....

8. (*a*) What do you understand by the term 'electronic configuration' ?

(*b*) Write down the electronic configuration of

(1) Sodium (atomic number=11)

(2) Sulphur (atomic number=16)

9. (*a*) The serial number of a shell outward from the nucleus is *n*. What is the maximum number of electron that this shell can have ?

(*b*) What is the maximum number of electrons in an outermost shell ?

10. From the symbol $^{40}_{20}Ca$ state

(1) The mass number of Ca

(2) The atomic number of Ca

(3) The electronic configuration of Ca

(4) The composition of the nucleus of Ca

11. Three different atoms of hydrogen are represented as $^{1}_{1}H$, $^{2}_{1}H$ and $^{3}_{1}H$.

(1) What do the sub and super-scripts in these symbols represent ?

(2) What factor accounts for the change in the superscripts (1, 2, and 3) though the element is the same ?

(3) What are such atoms called ?

(4) Draw the atomic structure of these atoms in the space given below :

$^{1}_{1}H$	$^{2}_{1}H$	$^{3}_{1}H$

12. (*a*) Atoms of chlorine are of two types. One type of atoms have a mass number of 35, The other type of atoms have a mass number of 37. Complete the following table showing the composition of these atoms :

Mass Number	*Protons*	*Electrons*	*Neutrons*
35	17		
37		17	

(*b*) What are the similarities in the atomic structures of the two isotopes ? ....

....

(*c*) What is the difference in the atomic structures of the two isotopes ? ....

....

(*d*) What is the appropriate term for such atoms of an element ? ....

13. Complete the following table :

Element	*Mass Number*	*Atomic Number*	*Number of protons*	*Number of neutrons*	*Electronic configuration*
Potassium	39		19		
Phosphorus	31			16	

14. Considering the isotopes of chlorine, $^{35}_{17}Cl$ and $^{37}_{17}Cl$, explain the reason why (1) the two isotopes have identical properties, and (2) the relative atomic mass of ordinary chlorine is not a whole number.

(1) ....

....

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(2 ....

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15. How would you explain that the two isotopes of chlorine (mass numbers 35 and 37) are not different elements ? ....

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16. Draw atomic diagrams to respresent the strictures of (1) Carbon atom, $^{12}_{6}C$, (2) sodium $^{23}_{11}Na$. (3) chlorine atom. $^{35}_{17}Cl$, and (4) argon atom $^{40}_{18}Ar$.

$^{12}_{6}C$	$^{23}_{11}Na$	$^{35}_{17}Cl$	$^{40}_{18}Ar$

17. Draw the atomic diagrams to represent the two isotopes of phosphorus : ${}^{30}_{15}P$ and ${}^{31}_{15}P$.

${}^{30}_{15}P$	${}^{31}_{15}P$

18. (*a*) Why do atoms combine to form molecules ? ....

....

(*b*) How do atoms combine to form molecules ? ....

....

19. (*a*) What is the characteristic feature of the electron configurations of the inert gases (except helium) ? ....

....

(*b*) Chlorine (atomic number 17) readily forms the negative chloride ion, Cl^- and potassium (atomic number 19) readily forms the positive ion, K^+. However, argon (atomic number 18) forms neither a positive ion nor a negative ion. Explain. ....

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20. (*a*) Explain the meaning of the term ion ? ....

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(*b*) Explain, with a suitable example how an electrovalent bond is formed. ....

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21. (*a*) How is a covalent bond formed between two elements ? ....

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(*b*) (*i*) What are single covalent bond, double covalent bond, and triple covalent bond ? ....

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(*ii*) Give one example, with formula, each of a molecule containing a single covalent bond, a double covalent bond, and a triple covalent bond. ....

....

....

22. What is the difference between the structures of compounds having electrovalent bonds and covalent bonds ?

23. (*a*) Why are electrovalent compounds called ionic compounds ?

(*b*) Why are covalent compounds called molecular compounds ?

24. Element X has the electronic configuration 2, 8, 18, 8, 1. Without identifying X, answer the following :

(*a*) What is the sign and charge on a simple ion of X ?

(*b*) Will X have oxidizing or reducing properties, and why ?

25 Explain by means of (*a*) equations, (*b*) electron-dot symbols the combination of sodium and chlorine to give sodium choride.

(*a*)

(b)

26. Explain with the help of simple diagrams the formation of (a) $MgCl_2$ and (b) CCl_4.

a. $MgCl_2$	b. CCl_4

27. The mass number and electronic configuration of five elements A, B, C, D, and E are as follows :

	A	B	C	D	E
Mass Number	9	19	23	28	40
Electronic configuration	2, 2	2, 7	2, 8, 1	2, 8, 4	2, 8, 8

(a) Name the element which has 22 electrons in the nucleus. ....

(b) What is the atomic number of C ? ....

(c) (i) Name the pairs of atoms which will combine by electrovalent bonds. ....

....

(ii) Give the formula of the compound corresponding to each pair, indicating the charge on the ions. ....

(d) Which type of bond will form between B and D ? ....

(e) Give the formula of the molecule formed by combination of B and D. ....

(f) Give the electron-dot structure of the molecule D_2 in the space given provided.

(g) Atoms of which element will not combine with other atoms to form molecules ? ......

(h) To which group of elements does E belong ? ....

28. (*a*) Give the electronic configuration of the elements (1) $_{14}Si$, (2) $_{17}Cl$, and (3) $_{20}Ca$,

(1) .... (2) .... (3) ....

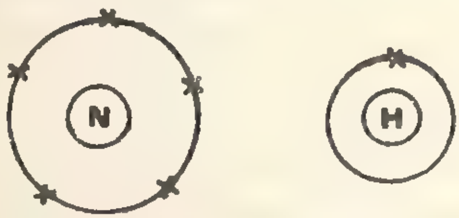
(*b*) Explain by means of diagrams only the combination of (1) $_{20}Ca$ and $_{17}Cl$, and (2) $_{14}Si$ and $_{17}Cl$.

(1) (2)

(*c*) Name the type of bond between $_{20}Ca$ and $_{17}$ Cl. ....

(*d*) Name the type of bond between $_{14}Si$ and $_{17}Cl$. ....

29 The formula of ammonia molecule is NH_3. A nitrogen atom has 5 electrons in the outer shell and a hydrogen atom has one electron in the outer shell as shown in the following diagram (X represents an electron) :



Nitrogen atom Hydrogen atom

(*a*) Draw in the space provided below a diagram to show the formation of ammonia molecule by the combination of one nitrogen atom and three hydrogen atoms.

(*b*) What type of bond exists between the nitrogen and hydrogen atoms in the ammonia molecule ? ....

30. A carbon atom has 6 electrons and an oxygen atom has 8 electrons.

(*a*) What is the number of electrons in the outermost shell of carbon ? ....

(*b*) What is the number of electrons in the outermost shell of onygen ? ....

(c) In the space provided below show the structure of a carbon dioxide molecule by means of an electron-dot-diagram representing the electrons of carbon by x and of oxygen by o.

31. (a) The atomic number of hydrogen is 1 and that of oxygen is 8. Showing the electrons of hydrogen by o and of oxygen by x, draw a diagram in the space given below to show how the outer electrons of the hydrogen and oxygen atoms are arranged in the water molecule.

(b) Is water an ionic compound or a molecular compound ? ....

32. The electronic configurations of some elements are as given below :

Elements :	H	Li	C	P	Cl	Ca
Electronic configuration :	1	2, 1	2, 4	2, 8, 5,	2, 8, 7	2, 8, 8, 2

(a) Complete the following table :

Combination of atoms of—	Formula of the compound	Type of bonding
1. Li and H		
2. Li and Cl		
3. C and Cl		
4. Ca and Cl		
5. H and Cl		
6. P and H		
7. Ca and H		

(*b*) By reference to high/low melting point, solubility/insolubility in water, solubility insolubility in benzene, and conduction/non-conduction of electricity in solution or molten state, state the properties of—

(1) Carbon tetrachloride, CCl_4. ....

....

....

(2) Calcium chloride, $CaCl_2$. ....

....

....

(3) Lithium chloride, LiCl. ....

....

....

33. (*a*) State *FOUR* general properties of electrovalent or ionic compounds.

1. ....
2. ....
3. ....
4. ....

(*b*) State *FOUR* general properties of covalent or molecular compounds.

1. ....
2. ....
3. ....
4. ....

34. In terms of electron-transfer (*i.e.*, gain or loss of electron/electrons), state how does each of the following changes occur :

(1) $Fe \rightarrow Fe^{2+}$ ....

(2) $Fe^{2+} \rightarrow Fe^{3+}$ ....

(3) $Fe^{3+} \rightarrow Fe^{2+}$ ....

(4) $Cu^{2+} \rightarrow Cu$ ....

(5) $O \rightarrow O^{2-}$ ....

35. Explain the following terms with reference to the transfer of electrons :

1. Oxidation. ....

....

2. Reduction. ....

....

36. Explain, in terms of transfer of electrons, which of the two elements is oxidized and which is reduced when sodium and chlorine combine to form sodium chloride.

....

....

....

....

....

37. Fill in the blanks in the following statements :

(1) The nucleus of an atom is made up of.............................and.............................

(2) The particles distributed around the nucleus of an atom are called............................

(3) The particles present in equal number in a neutral atom are ....

and ....

(4) The maximum number of electrons in the 3rd orbit outward from the nucleus is............................

(5) An atom contains four neutrons more than the protons in its nucleus. Its electronic configuration is 2, 8, 8. The atom is made up of .... protons .... neutrons, and .... electrons.

(6) An electrically charged atom is called ....

(7) An alluminium ion (atomic number 13) becomes an ion by .... electrons. The ion is represented as ....

(8) A ferric ion, Fe^{3+}, becomes a ferrous ion, Fe^{2}, by .... electron.

(9) In the formation of the ionic chloride MCl_3, ... electrons are transferred from atom .... to .... atoms .... of ....

10. A bond set up by transfer of two electrons from one atom of A to one or two atoms of B is called .... or .... bond.

(11) A bond set up by sharing of one pair of electrons between two atoms is called a

....

(12) Two atoms A and B become oppositely charged ions as follows :

$A-2e^{-}=$ .... and $B+e^{-}=$ ....

The formula of the compound which results is..............................

(13) When molten sodium chloride is electrolysed, ... ions are oxidized to give

and .... ions are reduced to give ....

(14) Metals are reducing agents because they can readily .... electrons ;

non-metals are oxidizing agents as they tend to .... electrons ....

□□

9

Properties of Gases ; Gas Laws

1. List the important general characteristics of gases. ....

....

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....

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2. According to the molecular theory of gases, the pressure exerted by a gas in a closed vessel is caused by the bombardment of its molecules on the walls of the vessel. On this basis explain how the pressure of a gas in a closed container will change

(*a*) if the gas is heated. ....

....

....

....

(*b*) if the volume is halved, keeping temperature the same. ....

....

....

....

3. (*a*) Compare the intervals of Kelvin and Celsius scales of temperature. ....

....

(*b*) how is Kelvin temperature related to Celsius temperature ? ....

....

4. (*a*) State Boyle's law in two different ways.

1. ....

....

....

2. ....

....

....

(*b*) A cylinder of hydrogen contains 10 m^3 of the gas under a pressure of 100 atm. What volume will this hydrogen occupy at atmospheric pressure, if the temperature remains the same. ....

....

....

5. (*a*) State Charle's law. ....

....

....

(*b*) A gas occupies 4·2 litres at 27°C. If the pressure is made to remain the same, what will be the volume of the gas at 54°C ? ....

....

....

....

6. State if the volume of a given mass of a gas will decrease or increase when

(1) pressure is decreased, temperature remaining constant. ....

(2) pressure is increased, temperature remaining constant. ....

(3) temperature is decreased, pressure remaining constant. ....

(4) temperature is increased, pressure remaining constant. ....

7. (*a*) the gas equation combines Boyle's law and Charles' law. State the gas equation.

....

....

(*b*) Give the mathematical form of the gas equation deciphering the symbols used.

....

....

....

....

....

(*c*) What are standard conditions of temperature and pressure (s.t.p) ? ....

....

(*d*) The volume of a gas is 150 litres at 27°C and 750 mm pressure. Calculate the volume of the gas at s.t.p

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....

8. Choose the correct word/words in the following statements :

(1) The pressure of a gas varies (directly/inversely) with temperature, if the volume remains the same.

(2) The volume of a gas (decreases/increases) as the pressure upon it is decreased, temperature remaining the same.

(3) The density of a gas will (decrease/increase) if its temperature is increased, pressure remaining the same.

(4) The Kelvin scale (has/does not have) negative temperatures.

(5) The statement : "at constant temperature the product of volume and pressure of a given mass of gas is constant" is (Boyle's law/Charles' law).

(6) The temperature-volume relationship of gases at constant pressure is given by (Boyle's law/Charles' law).

(7) If the original volume and temperature of a gas are V_1 and T_1 respectively, and the final volume and temperature of the gas are V_2 and T_2 respectively, then according to Charles' law, ($V_1 \times T_1 = V_2 \times T_2$ / $V_1 \times T_2 = V_2 \times T_1$).

10

Avogadro's Law

1. (*a*) State Avogadro's Law. ....

....

....

(*b*) Distinguish between the terms 'atom' and 'molecule'. ....

....

....

....

....

....

2. (*a*) What do you understand by the term 'atomicity' of an element ? ....

....

....

(*b*) What is a 'diatomic' molecule ? Give two examples. ....

....

....

(*c*) Give one example each of a monoatomic molecule, diatomic molecule, and triatomic molecule.

(*i*) Monoatomic molecule. ....

(*ii*) Diatomic molecule. ....

(*iii*) Triatomic molecule. ....

(*d*) What is meant by the statement that 'oxygen molecule is diatomic' ? ....

....

....

3. Define the following terms :

(i) Atomic weight. ....

....

....

(ii) Gram atomic weight. ....

....

(iii) Molecular weight. ....

....

....

4. Explain clearly what do you understand by the statement that the atomic weight of sulphur is 32. ....

....

....

....

....

5. (a) What is meant by a MOLE of an element ? ....

....

....

....

(b) What is Avogadro's number ? ....

....

....

6. (a) What does 'a mole of atoms of oxygen' stand for ? ....

....

....

(b) How many Mg^{2+} and Cl^- ions are there in a mole of magnesium chloride, $MgCl_2$?

....

....

(*c*) The atomic weight of magnesium is 24. Calculate the weight of one atom of taking magnesium Avogadro's number as $6 \cdot 0 \times 10^{-23}$.

(*d*) What is the weight in grams of 1·42 moles of calcium carbonate, $CaCO_3$?
[Ca=40, C=12, O=16]

(*e*) Rewrite the following equation in terms of moles of reactants and products :

$MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

7. (*a*) What is meant by the Molar Volume of gas ?

(*b*) 120 cm^3 of a gaseous oxide of carbon, X, at STP weigh 0·14 g. Taking the molar volume of a gas as 24000 cm^3 at STP, calculate the mass of a mole of X.

(*c*) From the information obtained in (*b*), derive the molecular formula of X.

(*d*) Write the equation for the reaction that occurs when copper (II) oxide is heated in an atmosphere of X.

8. (*a*) Calculate the weights of the following volumes of gases measured at STP (H=1, N=14, O=16, S=32) ?

(i) 1·12 litres of SO_2.

(ii) 4·48 litres of H_2S.

(iii) 5·60 litres of NH_3.

(b) Calculate the volumes at STP occupied by the following :

(i) 7 g of N_2.

(ii) 3·4 g of NH_3.

(iii) 4 g of O_2.

9. The mass of 5·6 litres of a gas 'X' at STP is 12 g. What is the molecular weight of X ?

10. 1·7 g of a gas occupies 2·24 litres at STP. What is the molecular weight of the gas ?

11. (a) What is vapour density ? How is the vapour density of a gas related to its molecular weight ?

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(*b*) The densities of hydrogen and a gas 'X' are 0·09 g/l and 1·35 g/l respectively at STP. Calculuate (*i*) the vapour density of X and (*ii*) the molecular weight of X

(*i*) ....

....

....

(*ii*) ....

12. (*a*) Distinguish between the empirical formula and molecular formula of a compound.

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(*b*) The molecular formula of glucose is $C_6H_{13}O_6$. What is its empirical formula ?

....

13. A compound contains 37·5% of carbon, 12·5% of hydrogen, 50·0% of oxygen by weight. Calculate its empirical formula. If the molecular weight of the compound is 32, what is its molecular formula. (C=12, H=1, O=16) ?

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14. In a compound of magnesium (Mg=24) and nitrogen (N=14), 18 g of magnesium is combined with 7 g of nitrogen. Deduce the empirical formula of the compound by answering the following questions :

(*i*) How many g-atoms of magnecium are equal to 7 g of it ?... ....

(*ii*) How many g-atoms of nitrogen are equal to 7 g of it ? ....

....

(*iii*) What is the simplest ratio of g-atoms of magnesium to g-atoms of nitrogen ?

....

(*iv*) Hence, what is the simplest formula of the compound ?

....

15. Carbon monoxide burns in oxygen according to the equation $2CO+O_2 \rightarrow 2CO_2$. Under the same conditions of temperature and pressure, what volume of carbon dioxide will form if 2 litres of carbon monoxide is burnt and what volume of oxygen will be used up ?

(*i*) Volume of carbon dioxide formed ....

(*ii*) Volume of oxygen used up ....

16. Complete the following statements :

(*i*) Under the same conditions of temperature and pressure, equal number of molecules of all gases will occupy equal ....

(*ii*) At STP the volume of 2 moles of a gas will be ....

(*iii*) One mole molecules of oxygen, the atomicity of which is 2, contain ... atoms of oxygen.

(*iv*) The empirical formula of a gaseous compound is XY_2. Its empirical formula weight is equal to its vapour density. The molecular formula of the compound is . ...

(*v*) The vapour density of water vapour, H_2O, is ....

(*vi*) The valency of copper in CuO is .... and in Cu_2O is ... .

(*vii*) The valency of sulphur in SO_2 is .... and in SO_3 is ....

(*viii*) The valency of an element M is 3. The formula of its oxide is .... and of its chloride is ....

11

Calculations Based on Chemical Equations

1. Zinc and hydrochloric acid react according to the equation $Zn + 2HCl \rightarrow ZnCl_2 + H_2$.

   2 moles of zinc is treated with excess of hydrocloric acid so that all zinc is used up.

   (*a*) How many moles of hydrochloric acid are used up ? ....

   (*b*) How many moles of hydrogen are liberated ? ....

   (*c*) What is the volume of the hydrogen liberated at s.t.p. ? ....

2. When zinc sulphide is strongly heated in air, it changes to zinc oxide and sulphur dioxide.

   The equation for the reaction is $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$

   What information does this equation convey with regard to—

   (*a*) *molecular proportion of substances* ? ....

   ....

   ....

   ....

   (*b*) *relative number of moles of substances* ? ....

   ....

   ....

   (*c*) *relative weights of substances* (Zn=65, S=32, O=16) ? ....

   ....

   ....

   ....

   (*d*) *relative volumes of gaseous substances* ? ....

(e) What volume of sulphur dioxide at STP will be produced when 1 mole of zinc sulphide is used up ?

(f) What weight of zinc sulphide is needed to produce 11·2 litres of sulphur dioxide at STP ?

(g) How much zinc oxide will form if 38·8 kg of zinc [illegible] completely used up ?

3. (a) Write the equation for the decomposition of lead (II) nitrate crystals by heat.

(b) What would be the maximum volumes of the two gases (in litres) at s.t.p. produced on heating 0·1 mole of lead (II) nitrate crystals ?

4. From the equation $N_2 + 3H_2 \rightarrow 2NH_3$, calculate the volume of ammonia that will be produduced when 12 litres of hydrogen has combined with nitrogen, all volumes being measured at s.t.p.

5. Calcium carbonate reacts with hydrochloric acid according to the equation

$$CaCO_3+2HCl \rightarrow CaCl_2+H_2O+CO_2$$

If 20 g of pure calcium carbonate is used, calculate—

(*a*) the weight of calcium chloride formed [Ca = 40, C = 12, O = 16, Cl = 35.5, H = 1].

(*b*) the volume at STP of carbon dioxide produced.

6. The complete combustion of butane, C_4H_{10} proceeds according to the equation :

$$2C_4H_{10}+13O_2 \rightarrow 8CO_2+10H_2O, \ [H=1, C=12].$$

(*i*) How many moles of oxygen would be needed for the complete combustion of 174 g of butane and (*ii*) what volume of carbon dioxide would be formed at s.t.p.

7. (*a*) Write a balanced equation for the action of heat an zinc carbonate.

(*b*) 25 g of solid zinc carbonate was heated to constant mass. Calculate the weight of the solid residue and the volume at s.t.p. of carbon dioxide obtained. [Zn = 65, C = 12, O = 16].

8. A paraffin wax candle composed of 80 per cent of carbon and 20 per cent of hydrogen

weighs 300 g. Find the weight of the products by the complete combustion of the candle. [H=1, C=12, O=16].

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9. 1 dm^3 of oxygen at s.t.p. is made to react with 2 dm^3 of carbon monoxide at s t.p. Calculate the weight of the carbon dioxide formed. (C=12, O=16).

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10. 34 g of pure hydrogen peroxide was decomposed. Calculate the weight and volume at s.t.p. of the oxygen evolved. [H=1, O=16].

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11. Taking the atomic weights H=1, N=14, O=16, and Cu=64, calculate from the equation

$3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 4H_2O + 2NO$

(*i*) the mass of copper needed to react with 63 g of nitric acid.

(*ii*) the volume of nitric oxide that can be collected at s.t.p. (the gram molecular volume of a gas at s.t.p.=22·4 litres.

12. What weight of copper will be precipitated by adding 1·2 g of magnesium to an excess of copper sulphate solution ? [O=16, Mg=24, S=32, Cu=64].

T.O.

12

Electrolysis

1. Explain the terms (1) Electrolyte (2) Anode (3) Cathode, and (4) Electrolysis.

(1)

(2)

(3)

(4)

2. Explain the following observations :

(1) A solution of cane sugar does not conduct electricity but a solution of common salt does.

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(2) Copper is a good conductor of electricity, but it is a non-electrolyte.

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3. Distinguish between 'electrolytic dissociation' and 'ionization'.

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4. (*a*) Sodium chloride crystal is made up of Na^+ and Cl^- ions. However, sodium chloride crystals will not conduct electricity but aqeous sodium chloride or molten sodium chloride will conduct electricity. Explain. ....

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(b) What happens when fused sodium chloride is electrolyzed, and explain how electricity is conducted through it? ....

....

....

....

(c) Give equations for the reactions occuring at the electrodes during the electrolysis of fused sodium chloride.

(i) At the anode: ....

(ii) At the cathode: ....

5. Liquid hydrogen chloride does not conduct electricity but a solution of hydrozen chloride in water conducts electricity. Explain. ....

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6. Name three classes of electrolytes and given an equation for the dissociation of one compound of each class.

Three classes of electrolytes: ....

Equation (1) ....

Equation (2) ....

Equation (3) ....

7. The diagram in the margin shows the set up of an apparatus for determining and comparing the electrical conductivity of various liquids which are placed in turn in the electrolytic cell.

(1) What is the liquid described as—

(*i*) when the bulb lights up brightly ?

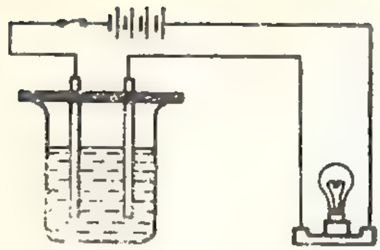
....

(*ii*) when the bulb lights up dimly ?

....

(*iii*) when the bulb does not light up ?

....



(2) Give two example of each of the three types of liquids :

(*i*) ....

(*ii*) ....

(*iii*) ....

8. The diagram in the margin represents the set up of an electrical circuit for the electrolysis of lead bromide, $PbBr_2$.

(1) Electric current does not flow when lead bromide is in solid state. When lead bromide melts, the current flows and the bulb lights up. Why ?

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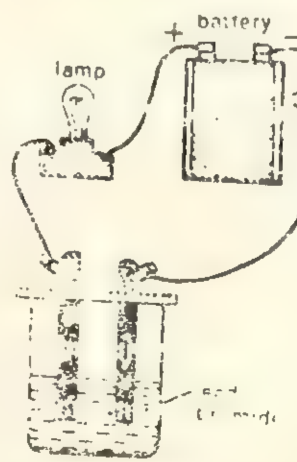
(2) The products formed during the electrolysis of lead bromide are :

(*i*) at the anode : ....

(*ii*) at the cathode : ....



(3) The reactions that occur during the electrolysis of lead bromide are

(*i*) at the anode : ....

(*ii*) at the cathode : ....

(4) Among the following factors, put a tick mark (√) at those which would increase the production of lead :

(*i*) increasing the quantity of lead bromide ;

(*ii*) increasing the temperature of molten lead bromide ;

(*iii*) using a higher current ;

(*iv*) passing current for a longer time.

9. (*a*) Describe what you would observe when two platinum electrodes connected to the terminals of an electric battery are dipped into water containing a little sulphuric acid and graduated tubes full of water are invested over them (see diagram in the margin).

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(*b*) Explain the reported observations.

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10. Aqueous copper (II) sulphate was electrolyzed using platinum electrodes.

(*a*) Name the product and the equation for the reaction occuring

(*i*) at anode : product. .... Equation. ....

(*ii*) at cathode : product. .... Equation. ....

(*b*) In another experiment, instead of platinum electrodes copper electrodes were used. Name the product and the equation for the reaction occuring.

(*i*) at anode : Product. .... Equation. ....

(*ii*) at cathode : Product. .... Equation. ....

(*c*) What is the industrial importance of the electrolysis of copper (II) sulphate using copper electrodes ? ....

....

....

11. (*a*) Describe what you would see at the carbon anode and the platinum cathode during the electrolysis of aqueous copper (II) chloride. ....

....

....

(*b*) Write ionic equation for the reactions at the electrodes.

(*i*) At the anode : ....

(*ii*) At the cathode : ....

12. Complete the following table :

Electrolyte	*Cathode*	*Anode*	*Product and equation for reaction at cathode*	*Product and equation for reaction at anode*
(1) Dil. sulphuric acid	Platinum	Platinum	Product : Equation :	Product : Equation :
(2) Aqueous Copper (II) sulphate	Platinum	Platinum	Product : Equation :	Product : Equation :
(3) Aqueous Copper (II) sulphate	Copper	Copper	Product : Equation :	Product : Equation :

13. (*a*) **Explain the electrode reactions occuring in the electrolysis of aqueous Copper (II) sulphate using copper electrodes.** ....

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(*b*) What is the net result of these reactions ? ....

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14. (*a*) Complete the following equations which represent electrode reactions during the electrolysis of certain substances :

(*i*) $2O^{2-} \rightarrow O_2 +$ .... (*ii*) .... $+ e^- \rightarrow Ag$

(*iii*) .... $\rightarrow Cl_2 + 2e^-$ (*iv*) $2H^+ +$ .... $\rightarrow$ ....

(*b*) (*i*) Which of the above reactions occur at the anode ? ....

(*ii*) Which of the above reactions occur at the cathode ? ....

(*c*) State two industrial uses of electrolysis. ....

....

....

(*d*) Name any four metals which are produced by electrolytic processes.

....

15. (*a*) What do you understand by the term electroplating ? ....

....

....

....

(*b*) What are the electrolyte, anode, and cathode in silver-plating ?

Electrolyte : ....

Anode : ....

Cathode : ....

(*c*) What are the electrode reactions that take place in silver plating ?

(*i*) At anode : ....

(*ii*) At cathode : ....

(*d*) Explain how silver is deposited on the cathode material in silver-plating ?

....

....

....

....

16. (*a*) Calcium metal is obtained by the electrolysis of fused calcium chloride. Write equations for the reactions that take place at the electrodes.

(*i*) At anode : ....

(*ii*) At cathode : ....

(*b*) Aluminium is obtained by the electrolysis of fused alumina. Write equations for the reactions that take place at the electrodes.

(*i*) At anode : ....

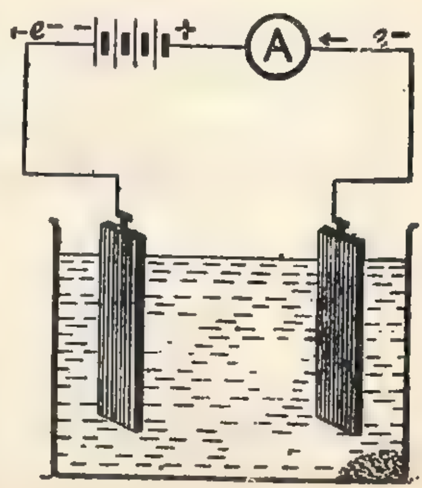
(*ii*) At cathode : ....

17. The diagram in the margin shows the set-up for the electrolytic refining of copper.

(*a*) Name the electrolyte : ....

(*b*) The anode consists of ....

(*c*) The cathode consists of ....



(*d*) What happens at the anode ? ....

(*e*) What happens at the cathode ? ....

(*f*) What happens to the electrolyte ? ....

(*g*) Reduction occurs at the ....

(h) Oxidation occurs at the ....

18. When copper is electrolytically refined, the weight of the anode progressively decreases and that of cathode progressively increases. However, the electrolyte does not undergo any change during the process. Explain. ....

....

....

....

19. Write ionic equations for the following reactions :

(i) Neutralization of an acid and an alkali. ....

(ii) Displacement of hydrozen from dilute acids by zinc. ....

(iii) Precipitation of silver chloride when solutions of silver nitrate and sodium chloride are mixed. ....

(iv) Liberation of carbon dioxide from carbonates by the action of dilute acids.

....

(v) Displacement of copper from copper (II) sulphate solution by iron.

....

20. (a) Complete the following statements :

(i) A substance which in solution conducts electricity is called ....

(ii) Liquified hydrogen chloride or a solution of hydrogen chloride in toluene does not conduct electricity because ....

a solution of hydrogen chloride in water conducts electricity because. ....

(iii) A calcium ion is discharged as calcium atom by ....

(iv) When acidulate water is electrolysed, oxygen is evolved at the ....

(v) The decomposition of an electrolyte of the passage by electric current through it is called ....

(vi) During the electrorefining of copper, the weight of the .... progressively decreases.

(vii) Solid sodium chloride does not conduct electricity because ....

....

....

(*viii*) During electrolysis, the cations move towards and are discharged at ....

....

(*b*) Select the correct word in the following statements :

(*i*) (Sugar/salt) is a non-electrolyte. ....

(*ii*) (Solid/fused) lead bromide does not conduct electricity. ....

(*iii*) Pure water is (an electrolyte/a non-electrolyte). ....

(*iv*) Hydrogen chloride (dissociates/ionizes) when dissolved in water. ....

(*v*) Ionization is a (reversible/non-reversible) process. ....

(*vi*) In solution or in molten state a (strong/weak) electrolyte consists almost entirely of ions. ....

(*vii*) In the electrolysis of acidulate water, oxygen is produced by the discharge of (O^{2-}/OH^-) ions at the anode. ....

(*viii*) During electrolysis, anions undergo (oxidation/reduction) at the (cathode/anode).

....

(*ix*) The reactions occurring at the cathode during electrolysis involve (oxidation/reduction). ....

(*x*) Elements liberated at the anode during electrolysis are said to be (electronegative/electropositive). ....

□□

13

Carbon

1. (*a*) What is meant by the term 'allotropy'? ....

....

....

(*b*) What is the cause of allotropy? ....

....

2. Name the crystaline allotropes of carbon and state two important/large-scale uses of each allotrope.

Name	*Uses*
(1)	(*i*) ....
	(*ii*) ....
(2)	(*i*) ....
	(*ii*) ....

3. State three points of difference between diamond and graphite

Diamond	*Graphite*
(*i*)	(*i*) ....
(*ii*)	(*ii*) ....
(*iii*)	(*iii*) ....

4. How would you establish that the different allotropes of carbon are the same element ?

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5. (*a*) What is meant by the term 'destructive distillation' ? ....

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....

....

(*b*) What products are obtained when wood is heated out of contact with air ? ....

....

....

6. (*a*) The specific gravity of charcoal is 1·5, yet, it floats on water. Why ? ....

....

....

(*b*) Define adsorption. ....

....

....

(*c*) What is activated charcoal ? ....

....

....

....

....

7. Give equations for the reactions of carbon (charcoal) with the following substances at high temperatures : (*i*) iron (II) oxide, (*ii*) carbon dioxide, (*iii*) steam, (*iv*) concentrated sulphuric acid, and (*v*) concentrated nitric acid.

(i) ....

(ii) ....

(iii) ....

(iv) ....

(v) ....

8. Give *three* uses of charcoal (other than its use as a fuel). ....

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....

....

9. (*a*) What is bone black ? ....

....

(*b*) What does bone black consist of ? ....

....

....

(*c*) What is bone black used for ? ....

10. Complete the following statements :

(1) The phenomenon of an element existing in more than one form in the same physical state is called ....

(2) The densest form of carbon is ....

(3) The allotrope of carbon used as a dry lubricant is ....

(4) The use of diamonds as gems is based on their high ....

(5) Carbon, when heated with zinc oxide, combines with its oxygen to form ....

....

14

Oxides of Carbon

1. Blue flames are seen playing over a deep, brightly glowing coal fire. Explain the observation. ....

....

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....

....

2. (*a*) Write the balanced equation for the formation of carbon monoxide from carbon.

....

(*b*) (*i*) How is carbon monoxide obtained from oxalic acid in the laboratory ? ....

....

....

(*ii*) Write the balanced chemical equation for the reaction.

....

(*iii*) Which property of sulphuric acid is shown in this reaction ?

....

(*iv*) How would you separate and collect carbon dioxide from the mixture of gases produced in this reaction ? ....

....

....

....

(*c*) Why is it advised to prepare carbon monoxide in a fume cupboard ? ....

....

3. When lime water is added to a jar of carbon monoxide, it remains clear. If the gas is ignited and the gas jar shaken, the lime water turns milky. What is the inference from this observation ? ....

....

....

4. (*a*) Name the liquid in which carbon monoxide dissolves. ....

....

(*b*) Explain how carbon monoxide dissolves in this liquid. Write the chemical equation for the reaction, if any. ....

....

....

....

5. Write chemical equations for the action of carbon monoxide on the heated oxides of (*i*) copper, (*ii*) lead, and (*iii*) iron.

(*i*) ....

(*ii*) ....

(*iii*) ....

6. Carbon monoxide is used for the manufacture of phosgene (carbonyl chloride), sodium formate, and methyl alcohol. For each of these substances, write the conditions in which it is made and the balanced equation for the reaction.

(*i*) *Phosgene.* ....

....

....

(*ii*) *Sodium formate.* ....

....

....

(*iii*) *Methyl alcohol.* ....

....

....

....

7. (*a*) What is quicklime, chemically ? ....

(*b*) Quicklime is made by heating limestone which is calcium carbonate. However, the decomposition of limestone by heat is a reversible reaction : $CaCO_3 \rightleftharpoons CaO + CO_2$. How is the reverse reaction (*i. e.*, the recombination of CaO and CO_2) prevented ?

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(*c*) What would you observe when a small quantity of water is dropped over a lump of quicklime ? Write equation for the chemical reaction, if any. ....

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....

8. Write the chemical name, formula, action of heat, action of water for each of the following substances :

	Chalk	*Quicklime*	*Slaked lime*
1. Chemical name	....	....	....
2. Formula	....	....	....
3. Action of heat	....	....	....
	....	....	....
	....	....	....
			....
4. Action of water	....	....	....
	....	....	....
	....	....	....

9. (*a*) What is mortar ? ....

....

(*b*) What is mortar used for ? ....

....

....

(*c*) Explain the hardening of mortar when exposed to air. ....

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10. Describe the use of slaked lime in agriculture. ....

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11. Slaked lime is an alkali which is only sparingly soluble in water. A clear solution of slaked lime is used as a reagent in the laboratory.

(*a*) What is the name of this reagent ? ....

(*b*) What is this reagent used for ? ....

(*c*) What happens when this reagent is left exposed to air for a long time ? ....

....

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....

12. How are the following substances industrially made from slaked lime ? Give the

balanced chemical equation in each case.

(1) *Bleaching powder.* ....

....

....

(2) *Sodium hydroxide.* ....

....

....

13. (*a*) Write down the chemical formulae of the following substances :

(*i*) Sodium hydrogen carbonate : ....

(*ii*) Calcium hydrogen carbonate : ....

(*b*) Name two hydrogen carbonates which are known in the solid state. ....

....

(*c*) What is the action of heat on hydrogen carbonates, in general ? ....

....

....

....

(*d*) Write balanced chemical equation for the action of heat on

(*i*) Sodium hydrogen carbonate : ....

(*ii*) Magnesium hydrogen carbonate : ....

14. State two ways in which carbon dioxide can be prepared from chalk. Write balanced chemical equation in each case.

(1) ....

....

(2) ....

....

15. (*a*) How is carbon dioxide prepared in the laboratory ? Give equation.

....

....

....

(*b*) Carbon dioxide is not collected over water. Why ?

....

(*c*) How is the carbon dioxide prepared in the laboratory collected and why ?

....

....

(*d*) How can carbon be obtained from carbon dioxide ? ....

....

....

....

(*e*) Give two large-scale uses of carbon dioxide. ....

....

....

....

16. Give the observations and chemical equations for what happens when—

(1) burning magnesium wire is introduced in a jar of carban dioxide. ....

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(2) carbon dioxide is passed through water coloured with blue litmus. ....

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(3) Carbon dioxide is passed through lime water for a considerable time, and then the resulting liquid is boiled ? ....

17. (*a*) What is *dry ice* and why it is so called ?

(*b*) What is the function of sodium hydrogen carbonate in baking powders ?

18. (*a*) What is a soda-acid fire extinguisher ?

(*b*) How does a soda-acid fire extinguisher operate ?

....

(c) Why should not a soda-acid fire extinguisher be used on fires [illegible] equipment ? ....

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....

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(d) Why is a soda-acid fire extinguisher not effective on oil fire ? ....

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19. (a) Oil fires are fought with foam type fire extinguishers. What substances are used in this type of a fire extinguisher ? ....

....

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(b) State the function of each substance used in a foam type fire extinguisher. ....

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20. State two importance consequences of carbon dioxide dissolved in water.

(1) ....

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(2) ....

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21. (*a*) Explain two ways by which carbon dioxide is added to the air.

(*i*) ....

....

(*ii*) ....

....

(*b*) Explain two ways by which carbon dioxide is removed from air.

(*i*) ....

....

(*ii*) ....

....

22. State three important *chemical* differences between carbon monoxide and carbon dioxide :

Carbon monoxide	*Carbon dioxide*
1.	....
....	....

2. ....

....

3. ....

....

23. (*a*) How would you convert carbon monoxide into carbon dioxide ? ....

....

....

(*b*) How would you convert carbon dioxide into carbon monoxide ? ....

....

....

Give equations.

24. State three ways carbon monoxide and carbon dioxide may be separated from a mixture of the two gases. ....

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25. Delete the wrong word/words in the following statements :

(1) Carbon monoxide may be prepared by the (oxidation/dehydration) of formic acid.

(2) Carbon monoxide is (a neutral/an acidic) oxide.

(3) The carbonate of (sodium/copper) is not decomposed by heat.

(4) A thick suspension of slaked lime is called (milk of lime/lime water).

(5) Sulphuric acid is not suitable for liberating carbon dioxide from (sodium carbonate/calcium carbonate).

(6) The reaction of carbon dioxide with lime water shows that it is (a neutral/an acidic) oxide.

(7) (Carbon monoxide/carbon dioxide) is used in the manufacture of urea.

(8) Carbon dioxide does not act as (an oxidizing/a reducing) agent.

15

Carbonic Acid and its Salts; Hardness of Water

1. Carbon dioxide dissolves in water giving a solution of carbonic acid, H_2CO_3. However, it has not been possible to isolate this acid. Explain the reason. ....

....

....

....

....

2. (*a*) What is the basicity of carbonic acid? ....

(*b*) Carbonic acid gives rise to two types of salts. Name these types and give the names and formulae of two salts of each type.

(*i*) ....

....

(*ii*) ....

....

3. (*a*) Name the carbonates which are soluble in water. ....

....

(*b*) How will you prepare insoluble metal carbonates? Give two examples with balanced equations. ....

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....

....

(c) (i) What would you observe when carbon dioxide is bubbled into a suspension of calcium carbonate in water for a long time? ....

....

....

(ii) Explain your observation. ....

....

....

....

....

....

(iii) Give chemical reaction, if any, that occurs under (i).

....

(d) What happens when the product from (c) (i) is

(i) boiled? ....

....

(ii) shaken with soap solution? ....

....

(iii) added to sodium carbonate solution? ....

....

(e) Give chemical equations for the reactions under (d) representing soap as sodium stearate and by the formula NaSt.

(i) ....

(ii) ....

(iii) ....

4. When soap is rubbed with hard water, lather is not readily formed and a scum is formed instead. Explain this by considering soap as sodium stearate. ....

....

....

5. (*a*) When hard water is used for raising steam in boilers, a white crust is formed on the inner walls of boilers. Explain the formation of this crust called '*boiler scale*'.

(*b*) What are the disadvantages from the formation of boiler scale?

6. (*a*) Name the salts which cause temporary hardness in water.

Name the salts which cause permanent hardess in water.

What is the difference between temporary and permanent hardness in water ?

How would you prepare a sample of (*i*) temporary hard water, and (*ii*) permanent hard water from lime water. Write the equations for the reactions involved in each case.

(i)

(ii)

Explain the significance of the words 'temporary' and 'permanent' in describing the two types of hard water.

8. State two methods, giving chemical equations, for removing temporary hardness in water.

(1)

(2)

9. State two methods, giving chemical equations, for removing permanent hardness in water caused by dissolved calcium chloride.

(1)

(2)

10. (*a*) What is 'permutit' ? How is it made ?

(*b*) How does permutit remove the hardness in water ?

(*c*) How is exhausted permutit reactivated ?

11. Delect the incorrect word/words in the following statements :

(1) A white precipitate will form if (sodium carbonate/sodium hydrogen carbonate) is added to magnesium sulphate solution.

(2) When heated, (sodium carbonate/sodium hydrogen carbonate) gives off carbon dioxide.

(3) A solution of (sodium hydrogen carbonate/magnesium hydrogen carbonate) gives a white preciptate on boiling.

(4) Ordinary soap may be represented as (sodium stearate/calcium stearate).

(5) The hardness of water caused by dissolved calcium hydrogen carbonate and calcium sulphate both can be removed by addition of (caustic soda/slaked lime).

16

Carbon Fuels

1. (*a*) What is meant by a 'fuel'? ....

....

....

(*b*) Sulphur burns in air giving out considerable heat. Yet, it is not ordinarily used as a fuel. Why? ....

....

....

....

2. (*a*) What do you understand by the term 'calorific value' of a fuel? ....

....

....

....

(*b*) "The calorific value of coal gas is 4·5 kcal per kilogram". Explain this statement.

....

....

....

3. (*a*) What is coal and how does it occur? ....

....

....

....

....

(*b*) How was coal formed in nature ? ....

....

....

....

....

(*c*) Name the main varieties of coal in the order of increasing carbon content. ....

....

....

(*d*) Which variety of coal is used in domestic fires ? ....

4. Anthracite is the variety of coal which contains maximum carbon. Yet, it is not used as a fuel in homes. Why ? ....

....

....

....

5. (*a*) The diagram given in the margin illustrate the set-up for demonstrating the destrictive distillation of coal in the laboratory.

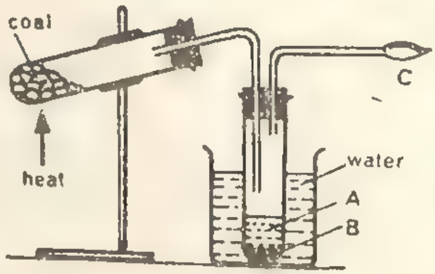
(*i*) What is meant by 'destructive distillation' ?

....

....

....

....



(*ii*) Label the diagram by writing names corresponding to the substances marked A, B, and C.

A : .... B : .... C : ....

(*iii*) Name the residue that remains in the test tube in which coal is being heated, and give important uses of this compound.

Name : .... *Uses* : ....

....

....

(*b*) At the end of the experiment, the liquid A was tested with a red litmus paper which was turned blue. Why ? ....

....

(*c*) Name four basic products obtained by the destructive distillation of coal. ....

....

(*d*) Name two reducing agents present in coal gas.

1. .... 2. ....

(*e*) Why is it dangerous to inhale coal gas ? ....

....

....

6. (*a*) What is the chemical nature of petroleum ? ....

....

....

(*b*) Three liquid fuels are obtained from crude petroleum, viz., petrol, kerosene, and fuel oil. Name the process which is employed for this purpose. ....

....

(*c*) Give one important use of each one of the following :

(*i*) *Petrol* : ....

(*ii*) *Kerosene* : ....

(*iii*) *Fuel oil* : ....

(*d*) What is natural gas ? ....

....

....

(*e*) What is the use of natural gas ? ....

....

7. (*a*) What are hydrocarbons ? ....

....

(*b*) Two hydrocarbons, butane and isobutane, have the same formula C_4H_{10} but different

structures. What are such compounds called ? ....

(c) What is the name for the phenomenon of two or more different substances having the same molecular composition ? ....

(d) Write down the structures of butane and isobutane in the space given below :

Butane

Isobutane

8. (a) The cooking gas used in homes is known as LPG. What does LPG stand for ?

....

(b) What does L.P.G. consist of ? ....

....

(c) Why is LPG supplied in this form ? ....

....

....

....

....

(d) What happens when the valve of the LPG cylinder is opened ? ....

....

....

(e) What is the source of L.P.G. ? ....

9. (a) Name the main constituents of producer gas. ....

....

(b) How is producer gas made ? ....

....

....

....

(*c*) Why is the calorific value of producer gas low ? ....

....

....

(*d*) Why is producer gas not stored and is used at the works where it is made ? ....

....

....

10. (*a*) Name the main constituents of water gas. ....

....

(*b*) How is water gas made ? ....

....

....

(*c*) How is the calorific value of water gas increased ? ....

....

(*d*) The constituents of water gas can be separated by mixing it with steam and passing the mixture over hot iron oxide catalyst. One of the constituents is oxidized into a substance which can be dissolved out under pressure in water.

(*i*) Name the constituent that is left out after this process has been carried out.

....

(*ii*) Write the equation for the reaction of water gas and steam under the conditions described. ....

(*e*) What will happen if water gas is passed over heated copper oxide ? Give chemical equation(s) for the reactions involved. ....

....

....

....

11. Water gas gives more heat on burning than does an equal volume of producer gas. Explain. ....

....

....

....

....

....

....

12. (a) Kerosene, Indane, and coal gas are three common domestic fuels. Name two common products of the combustion of these fuels.

1. .... 2. ....

(b) Why are these products obtained from the combustion of all of these different fuels? ....

....

....

13. What type of reactions are involved in the burning of fuels in air? Give chemical equations. ....

....

....

....

....

....

....

14. Delete the incorrect word/words in the following statements :

(1) The calorific value of wood is (more/less) than that of coal.

(2) The variety of coal with the highest carbon content is (peat/anthracite).

(3) Coal used in domestic fires is (bituminous coal/anthracite).

(4) Coke (contains/does not contain) volatile matter.

(5) The highest proportion by volume in coal gas is of (hydrogen/carbon monoxide).

(6) The gaseous fuel which does not contain carbon monoxide is (LPG/coal gas).

(7) The calorific value of producer gas is (less/more) than that of coal gas.

□□

17

Hydrogen Chloride and Chlorine

1. (*a*) State one condition under which hydrogen and chlorine combine to give hydrogen chloride. ....

   (*b*) Write the equation for the reaction. ....

2. (*a*) How is hydrogen chloride prepared in the laboratory ? ....

   ....

   (*b*) Write the equation for the reaction. ....

   (*c*) How can hydrogen chloride prepared as described above be dried ? ....

   ....

   (*d*) Why are quicklime and phosphorus pentoxide not suitable for drying hydrogen chloride ? Give equations. ....

   ....

   ....

   ....

3. Write equation and describe what happens when—

   (*i*) hydrogen chloride is brought in contact with ammonia.

   ....

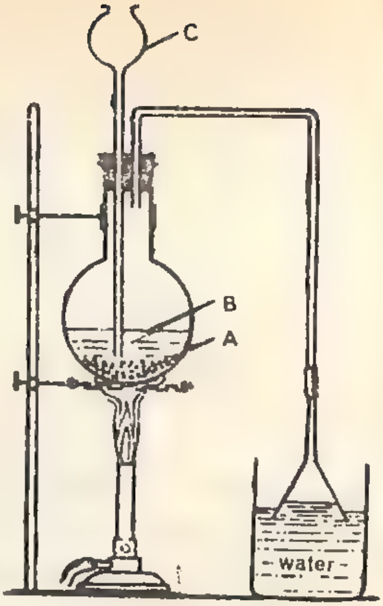
   ....

   (*ii*) hydrogen chloride is passed through a solution of silver nitrate. ....

   ....

   ....

4. (*a*) The diagram in the margin shows the arrangement of apparatus often used in the laboratory to dissolve hydrogen chloride in water.



(*i*) Label the diagram by writing appropriate names for A, B and C.

A : ....

B : ....

C : ....

(*ii*) Why is a funnel attached to the delivery tube ?

....

....

....

....

....

....

(*iii*) Dilute solutions of hydrogen chloride cannot be concentrated by evaporation beyond 22 2 per cent. Why ? ....

....

....

....

(*iv*) What is a 'constant boiling mixture' ? ....

....

....

....

....

(*v*) What is the percentage by weight of hydrogen chloride in concentrated hydro· chloric acid ? ....

(*b*) Write equation for and describe what happens when—

(*i*) Concentrated hydrochloric acid is heated with manganese dioxide ?

....

....

(*ii*) Concentrated hydrochloric acid is added to a solution of lead nitrate ? ....

....

....

(*c*) (*i*) Give the name and formula of a metallic oxide which will dissolve in hydrochloric acid to give a coloured solution. ....

....

(*ii*) Give the name and the formula of the substance in the coloured solution. ....

....

....

5. (*a*) Briefly describe and give equation for the preparation of (*i*) chlorine, (*ii*) lead (II) chloride, and (*iii*) ammonium chloride starting with hydrochloric acid.

(*i*) ....

....

....

(*ii*) ....

....

....

(*iii*) ....

....

(*b*) Give *two* tests to identify a dilute solution of hydrochloric acid.

(*i*) ....

....

....

....

....

(*ii*) ....

6. (*a*) What is aqua regia ?

(*b*) What is aqua regia used for ?

(*c*) Write equations to show the action of aqua regia on gold.

7. Hydrogen chloride does not affect litmus in the absence of moisture, but in the moist state or in solution it turns blue litmus red. Explain.

8. Chlorine can be produced by oxidizing hydrochloric acid with potassium permanganate, manganese (IV) oxide, or bleaching powder. (*a*) Write equations for the three reactions.

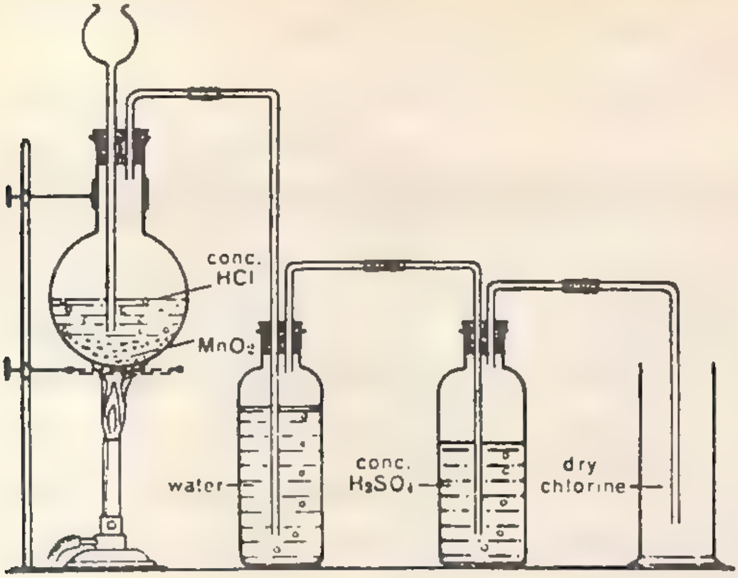
(*i*)

(*ii*)

(*iii*)

(*b*) Which of these substances will oxidize hydrochloric acid in cold ?

9. The diagram given below shows the arrangement of apparatus used for the preparation of chlorine in the laboratory.



(*a*) (*i*) Why should the thistle funnel reach almost to the bottom of the flask ? ....

....

....

(*ii*) Why is the issuing gas bubbled through water ? ....

....

....

(*iii*) Why is the gas coming out through water passed through concentrated sulphuric acid ? ....

....

(*iv*) (*a*) Why is the gas collected in the manner shown ? ....

....

(*b*) What part is played by manganese (IV) oxide ? ....

....

(*b*) Give the name and formula of any other oxide that could be used in place of manganese (IV) oxide. ....

....

10. (*a*) Write how chlorine can be prepared in the laboratory—

(*i*) *in cold* ? ....

....

(*ii*) *upon heating* ? ....

....

(*b*) Chlorine turns starch-iodide paper blue. **Explain this change.** ....

....

....

(*c*) Explain the bleaching action of chlorine. ....

....

....

....

....

11. Write equations for the reactions of chlorine with—

(*i*) Copper. ....

(*ii*) Phosphorus. ....

(*iii*) Aqueous solution of hydrogen sulphide. ....

(*iv*) Dilute and cold solution of sodium hydroxide.

....

(*v*) Concentrated and hot solution of sodium hydroxide.

....

(*vi*) Aqueous solution of potassium bromide. ....

(*vii*) Aqueous solution of iron (II) chloride.

....

(*viii*) Slaked lime. ....

12. A test tube full of a saturated solution of chlorine in water is inverted in a beaker full of the same solution, and the whole set-up is placed in sunlight. Bubbles of a colourless gas slowly collect in the test tube.

(*a*) State the name of the colourless gas. ....

(*b*) How will the solution affect litmus when no more of the gas evolves ? ....

....

(*c*) Write a balanced equation for the reaction between chlorine and water—

(*i*) *in dark.* ....

(*ii*) *in sunlight.* ....

13. If a filter paper soaked in turpentine is thrown inside a jar of chlorine, it **bursts** into red flames.

(*a*) What are the products of this reaction ? ....

....

(*b*) Write a balanced equation for the reaction.

....

(*c*) What does this reaction show about the chemical nature of chlorine.. ....

....

(*d*) State *three* uses of chlorine other than bleaching.

1. ....

....

2. ....

....

3. ....

....

14. (*a*) How would you prepare a sample of bleaching powder in the laboratory ? ....

....

....

....

(*b*) How can you get back chlorine from bleaching powder ? ....

....

....

(c) Give equation for the reaction involved in 13 (b). ....

....

(d) How can you obtain oxygen from bleaching powder ? ....

....

....

(e) Give equation for the reaction involved in 13 (d).

....

(f) Why is not advisable to use bleaching powder as a disinfectant when it is mixed with acids ? ....

....

....

....

15. Delete the incorrect word(s) in the following statements :

(1) Hydrogen chloride is (an ionic/a covalent) compound.

(2) A solution of hydrogen chloride in toluene does not behave as an acid. This is because (toluene is an organic liquid/ hydrogen chloride does not ionize in toluene).

(3) Aqua regia dissolves gold as it gives up nascent (chlorine/oxygen).

(4) Chlorine has great affinity for (hydrogen/oxygen).

(5) When chlorine was passed into a solution containing chloroform, the latter developed a violet colour. The solution contains potassium (bromide/iodide).

(6) Chlorine turns starch-iodide paper (blue/violet).

(7) The use of chlorine for sterilisation of water is based on its (affinity for hydrogen/strong oxidizing action).

(8) Bleaching powder is made by the action of chlorine on (quicklime/slaked lime).

□□

18

Nitrogen and Ammonia

1. (*a*) Outline briefly how a sample of nitrogen can be obtained from :

   (*i*) air. ....

   ....

   ....

   ....

   ....

   (*ii*) an ammonium salt. ....

   ....

   (*iii*) give chemical equation for the preparation of nitrogen from ammonium salt.

   ....

   ....

   (*b*) How is the nitrogen obtained from air different from that obtained from ammonium compounds ? ....

   ....

   ....

   ....

   ....

2. Describe *two* reactions by which nitrogen may be obtained from ammonia. Give equations : (*i*) ....

   ....

   ....

   (*ii*) ....

....

....

3. (*a*) Name three metals which can directly combine with nitrogen. ....

....

(*b*) What is the class name of the compounds of metals with nitrogen ? ....

....

(*c*) Discribe the reaction of any one compound of a metal and nitrogen with water and give the chemical equation. ....

....

....

....

4. (*a*) Write down the electron-dot formula of nitrogen molecule in the space below :

(*b*) Give a conclusive test for the identification of nitrogen. ....

....

....

....

....

....

(*c*) Write two *industrial* uses of nitrogen.

(*i*) ....

....

(*ii*) ....

....

5. Why do the manure heaps sometimes smell of ammonia ?

....

....

6. (*a*) How is ammonia prepared from an ammonium salt in the laboratory ? ....

....

....

(*b*) Give the equation for the reaction.

....

(*c*) How can the ammonia prepared in the laboratory be dried ? ....

....

(*d*) Why is it not possible to use concentrated sulphuric acid, phosphorus pentoxide, or anhydrous calcium chloride for drying ammonia ? ....

....

....

....

....

....

....

....

....

....

....

(*e*) How is ammonia collected in gas jars and why ? ....

....

....

7. (*a*) Write the equation for the preparation of ammonia from aluminium nitride.

....

(*b*) Name the product/products and write the equation for the reaction that occurs when ammonia is passed—

(*i*) *into water.* ....

....

(*ii*) *over heated copper (II) oxide.* ....

....

(*iii*) *through aqueous solution of iron (III) chloride.* ....

....

(*c*) State *two* large-scale uses of ammonia. ....

....

....

....

....

(*d*) State *one* household uses of ammonia. ....

....

....

8. Ammonia is manufactured by the direct combination of nitrogen and hydrogen.

(*a*) What is the above process called ? ....

(*b*) Name the sources from which nitrogen and hydrogen are obtained. ....

....

....

(*c*) Write the equation for the combination of nitrogen and hydrogen to form ammonia showing the heat change. ....

(*d*) In what ratio by volume are nitrogen and hydrogen mixed ? Explain why this ratio is used ? ....

....

....

(*e*) State the conditions for the best possible yield of ammonia by the direct combination of nitrogen and hydrogen. ....

....

(*f*) What catalysts are used in the above reaction ? ....

....

....

(g) Why is it necessary that the nitrogen and hydrogen used for making ammonia be very pure ? ....

(h) How is ammonia separated from the uncombined nitrogen and hydrogen ?

9. Starting with ammonia how would you prepare in the laboratory—

(i) a nitrogenous fertilizer ? ....

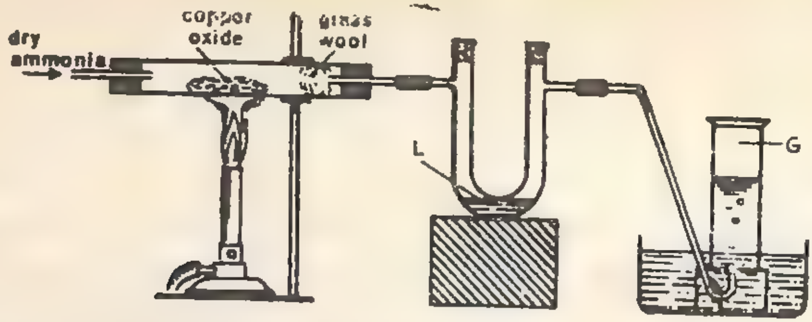
(ii) nitrogen ? ....

10. (a) What are the products when ammonia is burnt in oxygen ? Give equation for the reaction. ....

(b) What are the products when a mixture of ammonia and oxygen is passed over platinum heated to 800°C ? Give equation for the reaction. ....

(c) Give the formulae of all the molecules and ions in an aqueous solution of ammonia.

11. The figure given here shows dry ammonia being passed over heated copper (II) oxide.



(*a*) Name the liquid 'L' condensing in the U-tube. ....

(*b*) Name the gas 'G' collecting in the gas jar. ....

(*c*) Name the residue left in the glass tube after the reaction is complete. ....

(*d*) Write the equation for the reaction. ....

(*e*) What has been oxidized to what in this reaction ? ....

....

(*f*) What has been reduced to what in this reaction ? ....

....

(*g*) Name the oxidizing agent and the reducing agent in this reaction.

(*i*) Oxidizing agent. ....

(*ii*) Reducing agent. ....

12. The substance X is a colourless gas with a sharp odour. It is extremely soluble in water and the solution turns red litmus blue. In contact with hydrogen chloride it produces dense white fumes of a substance Y.

(*a*) What is X ? Give reasons to support your answer.

....

....

(*b*) Give the name and formula of the solution of X in water. ....

....

(*c*) What is Y ? Give the equation for its formation. ....

....

13. (*a*) A solution of ammonia in water turns red litmus blue and gives a brown precipitate

when added to iron (III) chloride solution. Explain these observations. ....

....

....

....

....

....

(*b*) What happens when ammonium hydroxide is slowly added in excess to a solution of copper sulphate ? Give equations also.

....

....

....

....

....

....

....

14. (*a*) Give the name and formula of the ammonium salt—

(*i*) which is used as a fertilizer. ....

(*ii*) which will yield nitrogen when heated. ....

(*iii*) which will produce nitrous oxide when heated. ....

(*b*) Give equations for (*ii*) and (*iii*) above.

1. ....

2. ....

15. Describe, with equations, the reaction of ammonia with chlorine. ....

....

....

....

....

16. Fill in the blanks in the following statements :

(1) Nitrogen molecule is made up of two atoms held together by .... bonds.

(2) Nitrogen combines with calcium carbide, CaC_2, at 1000°C to form ....

.... whose formula is ....

(3) Magnesium nitride reacts with water to give ....

and .... gas.

(4) Moist ammonia is dried by passing it through ....

....

(5) For maximum yield of ammonia by the combination of nitrogen and hydrogen, the pressure should be .... and the temperature relatively ....

(6) Ammonia .... heated lead oxide to lead.

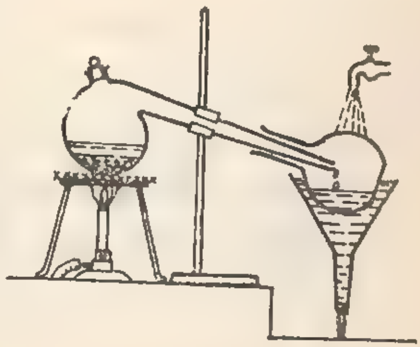
(7) Ammonia gives a brown coloration or precipitate with .... reagent.

□□

19

Nitric Acid, Nitrogen Cycle, and Fertilizers

1. The diagram in the margin shows the set up of an apparatus for the preparation of nitric acid.



(*a*) Name the piece of apparatus in which the reaction mixture is heated. ....

(*b*) Name the reactants. ....

....

(*c*) What is the temperature at which the reaction is carried out ? ....

(*d*) What is the flask in which nitric acid collects called ? ....

(*e*) Why is this flask cooled with a stream of water ? ....

....

(*f*) Write balanced chemical equation for the reaction.

....

(*g*) State if the nitric acid obtained is concentrated or dilute ? ....

(*h*) The nitric acid obtained has a brown colour. Why ? ....

....

....

....

....

(*i*) How can the brown colour of nitric acid be removed ? ....

....

2. Nitric acid is nowadays manufactured by the oxidation of ammonia.

(a) What is ammonia primarily oxidized to ?

(b) What is the oxidizing agent used.

(c) State the conditions under which ammonia is oxidized.

(d) How is the oxidation product of ammonia converted to nitric acid ?

3. (a) Describe, with equations, two reactions of nitric acid—

(i) *as an acid.*

(ii) *as an oxidizing agent.*

(b) State the reasons why the reactions given under 3*a* (*ii*) are regarded as oxidation reactions.

(c) How does the action of dilute nitric acid on zinc differs from that of dilute hydrochloric acid. Give equations.

(c) How does concentrated nitric acid affect skin, and why ?

4. Write the equations for the reactions of concentrated nitric acid with—

(i) sulphur.

(ii) sulphur dioxide.

(iii) hydrochloric acid.

5. Describe, giving equations, how does the reaction of dilute nitric acid with copper differs from that of concentrated nitric acid ?

6. (a) Describe and explain the action of pure concentrated nitric acid on iron.

(b) How does dilute nitric acid react with iron ? Give equation.

....

....

7. Describe two important large-scale uses of nitric acid. ....

....

....

....

8. State giving equation how would you obtain the following from nitric acid—

(*i*) hydrogen ? ....

....

(*ii*) nitrogen ? ....

....

....

....

(*iii*) oxygen ? ....

....

....

....

....

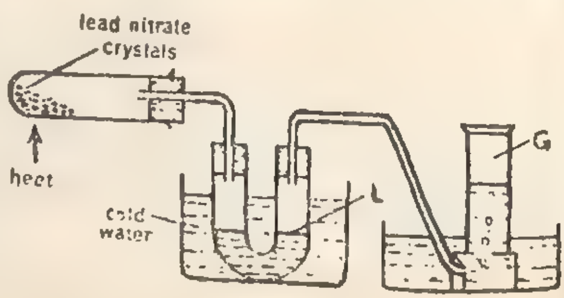
9. What would you observe when copper (II) nitrate crystals are heated ? Give equation for the reaction. ....

....

....

....

10. The diagram given here shows the apparatus used to study the effect of heat on lead nitrate.



(I) Name the liquid L and the gas G.

L is ....

G is ....

(2) Name the substance left in the test tube when the reaction is complete.

....

(3) Write the equation for the action of heat on lead nitrate.

....

(4) If cooling of the U-tube is ineffective, a brown gas passes out and reacts with the water in the trough. What happens in this reaction and what is its importance in industry ? Give equation. ....

....

....

....

....

....

(5) Why is copper nitrate, $Cu(NO_3)_2.3H_2O$, not suitable to use in place of lead nitrate to obtain a sample of pure liquid L ? ....

....

....

....

....

(6) Name a nitrate which on heating will yield G but not L. Give equation for the thermal decomposition of this nitrate. ....

....

11. (*a*) What is meant by 'nitrogen cycle' ? ....

....

....

....

(*b*) Describe the reactionsb y which nitrogen is removed from the air during thunderstorms.

....

....

....

(c) State one way in which nitrogen is removed from soil.

12. (a) What is meant by 'fixation of nitrogen' ?

(b) Why is it necessary for man to add nitrogen compounds to the soil ?

(c) Give the name of a nitrogenous fertilizer that should not be added to the soil along with lime. Give reason.

13. (a) Describe, giving equation, how ammonium sulphate is manufactured at Sindri.

(b) What is '*nitrolim*' ? How is it made ?

14. Fill in the blanks in the following statements :

(1) Nitric oxide combines with oxygen to form ....

(2) Nitrogen dioxide dissolves in water in the presence of oxygen. The resulting solution contains ....

(3) Hot concentrated nitric acid oxidizes organic matter to .... and ....

(4) Magnesium reacts with very dilute nitric acid to liberate ....

(5) Copper reacts with dilute nitric acid to liberate .... and with concentrated nitric acid to liberate ....

(6) .... is rendered passive by pure concentrated nitric acid.

(7) When silver nitrate is strongly heated, a residue of .... is left behind.

(8) .... has the highest percentage of nitrogen among all nitrogenous fertilizers. It is manufactured by the interaction of .... and ....

20

Sulphur and Its Compounds

1. Describe briefly the Frasch process used for obtaining sulphur from underground deposits. ....

....

....

....

....

....

....

....

2. (*a*) Sulphur can exist in both rhombic and monoclinic forms at 96°C. What is this temperature called ? ....

....

(*b*) Which of these forms is stable above 96°C ? ....

....

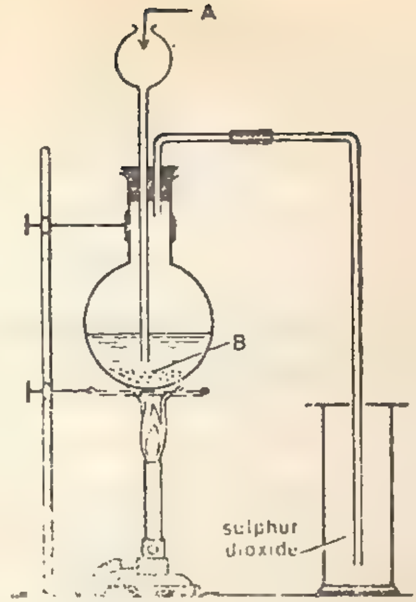
(*c*) Name the allotrope of sulphur which is insoluble in carbon disulphide.

....

(*d*) State two large-scale uses of sulphur. ....

....

3. (*a*) The diagram in the margin shows the preparation of sulphur dioxide in the laboratory.



(*i*) Name the substance A being poured through thistle funnel. ....

....

(*ii*) Name the substance B in the flask. ....

....

(*iii*) Write down the equation for the reaction that takes place. ....

....

(*b*) Describe any other method for the laboratory preparation of sulphur dioxide and give equation for the reaction. ....

....

....

(*c*) Sulphur dioxide is also called the 'anhydride of sulphurous acid'. What does this mean? ....

....

....

....

(*d*) How, and under what conditions, does sulphur dioxide react with chlorine? ....

....

....

(*e*) Give a distinctive test, other than its smell, for sulphur dioxide. ....

....

4. (*a*) (*i*) What happens when burning magnesium is introduced in a jar of sulphur dioxide? Name the products and write the equation of the reaction? ....

....

....

(ii) In what capacity does sulphur dioxide act in this reaction ? ....

....

(b) Give one balanced equation for the reaction of sulphur dioxide—

(i) as an oxidizing agent. ....

(ii) as a reducing agent. ....

(iii) as an acidic oxide. ....

(c) Explain the bleaching action of sulphur dioxide. ....

....

(d) Describe, giving reason, what you would observe and state what is formed when a jar of sulphur dioxide is placed mouth downward in a trough of water. ....

....

....

....

5. (a) Compare the bleaching action of chlorine and sulphur dioxide :

Chlorine	*Sulphur dioxide*
1.	1. ....
2.	2. ....
3.	3. ....

(b) Bleaching by chlorine is permanent; bleaching by sulphur dioxide is temporary Explain. ....

....

....

....

....

....

(c) Give two large-scale uses of sulphur dioxide. ....

....

[illegible] (a) [illegible] sulphur dioxide and oxygen combine to form sulphur trioxide? Give equation for the reaction.

(b) [illegible] when sulphur trioxide reacts with (give equation in each case) —

(i) calcium oxide.

(ii) concentrated sulphuric acid.

[illegible] an outline of the manufacture of sulphuric acid by Contact Process. Give equations for the reactions that take place at each stage.

(b) State the conditions favourable for the oxidation of sulphur dioxide to sulphur trioxide.

(c) In the contact process the catalyst is initially heated but subsequently external heating to stopped. Why?

....

....

(*d*) What is the catalyst used in the Chamber process. ....

....

(*e*) Write the net equation for the manufacture of sulphuric acid by the Chamber Process. ....

(*f*) What is the main use to which chamber acid is put? ....

....

8. A colourless liquid was slowly poured into cold water. Much heat was evolved. The resulting solution was found to contain H^+ and SO_4^{2-} ions.

(*a*) Name the oily liquid. ....

(*b*) Give two tests for the H^+ ions. ....

....

....

(*c*) Describe a test for the SO_4^{2-} ions and write the equation. ....

....

....

9. Explain briefly the facts: (1) dilute sulphuric acid reacts with zinc in cold giving off hydrogen, (2) concentrated sulphuric acid has no action on zinc metal in cold, but on heating sulphur dioxide and not hydrogen is evolved. ....

....

....

....

....

....

....

....

....

10. White equations, mentioning conditions, of the action of sulphuric acid on : (1) magnesium, (2) carbon, (3) sodium chloride, (4) bleaching powder, (5) iron sulphide, (6) cane sugar and (7) potassium nitrate.

11. What property of concentrated sulphuric acid is made use of in each of the following reactions ? Give equation for each reaction.

(1) In the preparation of hydrogen chloride gas from sodium chloride.

(2) In the preparation of hydrogen by diluting it and adding magnesium.

(3) In the preparation of carbon monoxide from formic acid, H.COOH.

(4) In the preparation of sulphur dioxide by heating it with copper.

12. **Describe, with equations, what happens when—**

(1) [illegible] vitriol (copper sulphate) are added to conc. sulphuric acid ?

(2) concentrated sulphuric acid is added to sugar ?

(1) ....

....

....

(2) ....

....

....

13. (a) Sulphuric acid may act in each of the following ways :

A. An acid forming sulphates which are soluble in water.

B. An acid forming sulphates which are insoluble in water.

C. A dehydrating agent.

D. An oxidizing agent.

E. A drying agent.

[illegible] the property (A to E) shown by sulphuric acid when—

(1) [illegible] passed through concentrated sulphuric acid. ....

(2) concentrated sulphuric acid is added to sugar. ....

(3) dilute sulphuric acid is added to lead nitrate solution. ....

(4) dilute sulphuric acid neutralizes sodium hydroxide. ....

(5) concentrated sulphuric acid is heated with sulphur. ....

(b) State three large-scale uses of sulphuric acid. ....

....

....

....

....

14. [illegible] the incorrect word(s) in the following statements :

(1) Extraction of sulphur by Frasch process involves (physical/chemical) changes only.

(2) At its melting point, sulphur consists of (eight-membered rings/long chains) of sulphur atoms.

(3) The allotrope of sulphur stable at ordinary temperature is (rhombic/prismatic) sulphur.

(4) When heated with concentrated sulphuric acid, sulphur is (oxidized/reduced).

(5) Sulphur dioxide bleaches colouring matter by (oxidation/reduction).

(6) Sulphuric acid forms (one/two) series of salts.

(7) Concentrated sulphuric acid chars paper as it is a (hygroscopic substance/strong dehydrating agent).

(8) Concentrated sulphuric acid produces a mixture of carbon monoxide and carbon dioxide by the dehydration of (formic acid/oxalic acid).

□□

21

Metals and Non-Metals

1. (*a*) Distinguish between metals and non-metals on the basis of the formation of ion.

....

....

....

(*b*) How do metals and non-metals differ in respect of the following :

(*i*) reaction with acids ? ....

....

(*ii*) reducing/oxidizing action ? ....

....

(*iii*) nature of oxides ? ....

....

(*iv*) nature of hydrides ? ....

....

(*c*) Name one metal which is—

(*i*) found free in nature. ....

(*ii*) extracted by reducing its oxide by carbon. ....

(*iii*) produced electrolytically. ....

2. (*a*) Complete the following table by giving the name and formula of the most important ore of each metal and the method of its extraction from that ore (electrolysis, reduction with carbon, roasting followed by reduction with carbon) :

Metal	Ore: Name	Ore: Formula	Method of extraction from ore
1. Iron			
2. Zinc			
3. Aluminium			

(*b*) Give the equation for the reaction to obtain lead from lead monoxide.

....

3. (*a*) Give the common names and formulae of two different kinds of ores from which iron is extrated. ....

....

(*b*) Besides iron ore and coke another substance (X) is added to the charge for the blast furnace. This substance serves to remove the silica present as impurity in the iron ore. Give the common name and formula of X. How does it remove silica ? Give equations for the reactions. ....

....

....

....

....

(*c*) Iron is produced in the blast furnace by the reaction represented by the equation :

$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$.

(*i*) Which substance has been oxidized ? ....

(*ii*) Which substance has been reduced ? ....

(*d*) Explain, giving equations, how carbon monoxide is produced in a blast furnace.

....

....

....

....

....

5. The following word equations summarize reactions occurring in the blast furnace to produce molten iron :

(1) Oxygen+Coke → Gas A ;

(2) Gas A+Coke → Gas B ;

(3) Gas B+iron oxide → Gas A+Iron.

(*i*) Identify A and B. ....

(*ii*) Explain why B is said to act as a reducing agent in reaction (3) ? ....

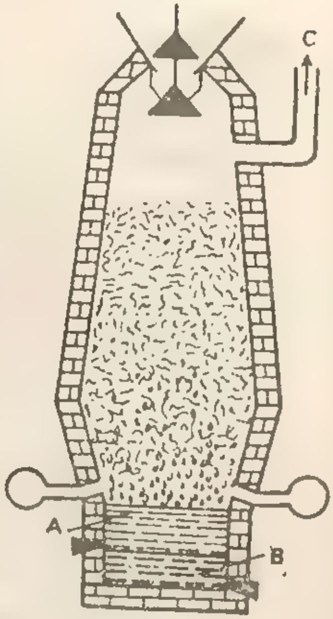
....

6. (*a*) Name three basic materials needed for the production of iron from its ore (do not include the ore). ....

(*b*) Iron is extracted from its ore in the type of furnace shown in the margin.

(*i*) What is such a furnace called ? ....

....



(*ii*) What is the arrangement at the mouth of the furnace known as ? ....

....

What is the advantage of this arrangement ?

....

....

....

(*iii*) What are the pipes through which air blast is sent in the furnace called ? ....

(*iv*) Two different molten substances collect at the bottom of the blast furnace in separate layers.

The substance A in the upper layer is ....

The substance B in the lower layer is ....

(v) What does the waste gas C that escapes from the blast furnace consist of ?

What is this waste gas used for ?

(vi) State the chemical name and formula of slag.

(vii) Write one use of slag.

(viii) State the main difference in the chemical compositions of pig iron and steel.

(ix) What is the main disadvantage of pig steel ?

(x) Describe briefly how pig iron is converted into steel ?

7. (a) Give the common name and formula of the ore from which aluminium is extracted.

(b) How is aluminium extracted from this ore ?

Give the equations for the reactions involved.

(c) Give a reason why aluminium cannot be obtained by reduction of its oxide by carbon or hydrogen.

(*d*) Give two reasons why aluminium is preferred to copper for the manutacture of cooking utensils. ....

....

8. (*a*) The extraction of zinc from zinc blende, ZnS, involves two main steps :

(*i*) roasting of zinc blende to obtain zinc oxide, and

(*ii*) reduction of zinc oxide to produce zinc.

Write equations for reactions (*i*) and (*ii*).

Reaction (*i*) ....

Reaction (*ii*) ....

(*b*) Give three main uses of zinc. ....

....

....

9. Name the metal which is used—

(1) for galvanizing iron. ....

(2) for making dry cells. ....

(3) for making accumulators of car batteries. ....

(4) for making building frames. ....

(5) for making foil for wrapping foodstuffs. ....

(6) in electrotyping. ....

(7) in flash light bulbs for indoor photography. ....

(8) in incendiary bombs. ....

□□

10. Give two large-scale uses for each of the following metals, mentioning the property of the metal on which each use depends.

Metal	*Use*	*Property on which the use depends*
1. Aluminium	1. .... 2.	1. .... 2. ....
2. Copper	1. .... 2.	1. .... 2. ....
3. Lead	1. .... 2.	1. .... 2. ....
4. Magnesium	1. .... 2.	1. .... 2. ....
5. Zinc	1. .... 2.	1. .... 2. ....

11. (*a*) Define an alloy. ....

....

(*b*) What are amalgams ? ....

(*c*) Name three important classes of alloys. ....

....

....

(*d*) Name the constituents and two useful properties of each one of the following alloys :

	Alloy	Constituents	Useful properties
(*i*)	Brass	....	....
(*ii*)	Bronze	....	....
(*iii*)	Type metal	....	....
(*iv*)	Magnalium	....	....
(*v*)	Stainless Steel	....	....

(*e*) Name two alloys used in the construction of aircraft. ....

....

12. A, B, and C are three metals. B liberates hydrogen from cold water; A and C do not. C displaces A when placed in an aqueous solution of one of its salts. Write A, B and C in the order of decreasing chemical reactivity. ....

13. (*a*) Write the metals iron, lead, and calcium in the order of decreasing chemical reactivity.

....

(*b*) Justify your arrangement by comparing the behaviour of these metals with—

(*i*) water or steam. ....

....

(*ii*) air or oxygen, when heated. ....

....

(*c*) How will the oxides of these metals behave when heated in hydrogen or coal gas ?

....

....

14. (*a*) Place the following metals in the order of decreasing chemical reactivity (*i e*., start with the most reactive) : lead, sodium, iron, zinc. ....

....

(*b*) A fifth metal 'M' reacts slowly with cold water but vigorously when heated with steam. It reacts with dilute acids giving hydrogen and a chloride MCl_2.

(*i*) Rewrite the activity list of these four metals with the metal M included at its proper place. ....

(*ii*) How can M be extracted ? ....

....

(*iii*) Write an equation for the action of heat on the carbonate of M.

....

(*iv*) What will happen if M is placed in a solution of zinc sulphate ? ....

....

Write the equation for the reaction. ....

15. The symbols of some metals are : Fe, Ag, Ca, Zn Al, and Mg.

(*i*) Arrange the metals in the order of decreasing order of reactivity.

....

(*ii*) Name the metal which will not displace hydrogen from dil. HCl. ....

(*iii*) Name the metal which forms the most stable hydroxide. ....

(*iv*) Name the metal which decomposes cold water. ....

Write the equation for the reaction. ....

(*v*) Name the metal whose oxide will give the metal on heating. ....

Write equation for the decomposition of oxide. ....

(*vi*) What will happen when zinc is added to iron sulphate solution ? ....

....

(*vii*) Name the metal which will form the most basic oxide. ....

16. The symbols X, Y and Z represent three imaginary elements in the decreasing order of chemical reactivity. Without identifying X, Y, and Z, answer the following questions :

(*i*) Which among X, Y, and Z occurs free in nature ? ....

(*ii*) Which among X, Y, and Z forms an oxide that gives the metal on heating ? ....

(*iii*) Which among X, Y, and Z forms the most basic oxide ? ....

(*iv*) Which among X, Y, and Z forms oxide that is not reduced when heated with carbon or hydrogen. ....

(v) Which of the X, Y, and Z can be used to displace one of the other two metals from a solution of its salts ? ....

....

(vi) What would you observe if Y is placed in a solution of copper nitrate and withdrawn after some time ? ....

....

(vii) Which of the X, Y, and Z is extracted by electrolytic process ? ....

17. An imaginary metal 'X' lies between sodium and calcium in the Activity Series of metals. State in words the reaction that will take place between—

(i) X and oxygen. ....

....

(ii) X and water. ....

....

(iii) X and dilute HCl. ....

....

18. Among the three metal elements X, Y, and Z, Z displaces X from the solutions of its salts, Y is obtained by the electrolysis of its molten chloride, while Z is obtained by the reduction of its oxide with carbon. Arrange X, Y, and Z in order of decreasing reactivity. ....

□□

22

Acids, Bases and Salts

(*a*) What is an acid ? ....

....

(*b*) Name two common acids found in fruits. ....

....

(*c*) Write equations for the ionization of hydrochloric acid and nitric acid in water.

....

....

(*d*) (*i*) How would you find out whether dilute hydrochloric acid is stronger or concentrated acetic acid ? ....

....

(*ii*) Which of these two acids is actually stronger ? ....

(*e*) State two simple ways to show that a given colourless liquid is an acid without tasting it. ....

....

....

....

....

(*f*) Distinguish between 'strong acids' and 'weak acids' on the basis of ionic theory.

....

....

2. (*a*) In what form does the hydrogen ion, H^+, exist in solution ? Give its name and formula. ....

....

....

(*b*) What do you understand by the term 'basicity of an acid' ? ....

....

....

(*c*) Write down the equations for the stepwise ionization of sulphuric acid.

....

(*d*) What are the common properties of the acids due to ? ....

....

....

3. (*a*) What is a base ? ....

....

(*b*) Name the classes of compounds to which bases belong. ....

....

(*c*) Give three examples of bases. ....

....

(*d*) Give the name and formula of a base that does not contain a metal. ....

....

(*e*) What is an alkali ? ....

....

(*f*) Give one example of an alkali. ....

(*g*) Name a base (or alkali) used in homes for cleaning glass surfaces. ....

....

(*h*) (*i*) What is the reaction between an acid and a base called ? ....

....

(*ii*) What are the products of this reaction ? ....

(*iii*) Write a chemical equation to illustrate this type of reaction.

....

(i) Calcium hydroxide is said to be a *diacid* base. What is meant by this ? ....

....

....

....

(j) What are the common properties of alkalis due to ? ....

....

....

4. Solutions of strong alkalis, such as sodium hydroxide, lose their strength when kept exposed to air for a long time. Explain the reason with equation, if any.

....

....

....

5. (a) What is the pH scale and what is its range ? ....

....

....

(b) The pH of a given solution is 7·0. What information does it give about the solution ? ....

....

(c) Hydrochloric acid is a stronger acid than boric acid. Which of the two acids will have higher pH ? ....

(d) Sodium hydroxide is a stronger base than boric acid. Which of the two will form a solution having higher pH ? ....

(e) Complete the following table :

Indicator	*Colour in acid solution*	*Colour in alkaline sodium*
1. Litmus	....	....
2. Phenolphthalein	....	....
3. Methyl orange	....	....

6. (*a*) Define 'neutralization' in terms of the theory of ionization. ....

....

....

....

....

....

....

....

(*b*) One mole of any strong monoacid acid reacts with one mole of any strong monoacid base to produce the same quantity of heat. Explain. ....

....

....

....

....

....

....

....

....

(*c*) What is the heat liberated in the interaction of one gram equivalent of a strong acid and one gram equivalent of a strong base called, and what is its value? ....

....

....

7. (*a*) Define 'salts' on the basis of the ionic theory. ....

....

....

(*b*) Distinguish between 'normal salts' and 'acid salts' giving one example of each type of salts. ....

....

....

....

8. Name three classes of substances that react with acids to form salts. Write the molecular and ionic equations for the reaction of a representative substance of each class.

Class of substance	*Representative substance*	*Molecular equation*	*Ionic equation*
1.	....	....	....
2.	....	....	....
3.	....	....	....

9. Some common methods employed for the preparation of salts are :

A. Direct combination of elements.

B. Reaction of a dilute acid and a metal.

C. Reaction of a dilute acid and an insoluble base.

D. Titration of a dilute acid and a soluble base.

E. Double decomposition between two salts in solution.

Select the most suitable method from A to E for the preparation of the following salts and give the equation for the reaction involved.

Salt	*Method*	*Equation*
Anhydrous iron (III) chloride		
Sodium sulphate		
Zinc chloride		
Lead chloride		
Copper sulphate		

10. Complete the table given below pertaining to the preparation of some salts :

	Name of the salt	*Method of preparation*	*Substances used*	*Equation for the reaction*
1.	Lead chloride	Double decomposition	1. 2.	
2.	Copper (II) sulphate	Action of acid on oxide	1. 2.	
3.	Zinc sulphate	Action of acid on metal	1. 2.	
4.	Sodium nitrate	Acid-base titration	1. 2.	

11. (*a*) Write a stepwise account of how you would prepare iron (II) sulphate. from iron.

....

....

....

....

....

....

....

....

(*b*) Give the equation for the equation involved.

....

12. Describe very briefly how you would prepare—

(1) copper sulphate from copper oxide by the method of neutralization. ....

....

....

....

(2) lead chloride from lead nitrate by the method of precipitation.

13. (*a*) Write an equation in each case to show the preparation of salt by :

(*i*) direct combination.

(*ii*) simple replacement.

(*iii*) neutralization.

(*iv*) precipitation.

(*b*) Name two solutions which on mixing will produce a precipitate of lead sulphate, and write the equation for the reaction.

14. How are crystals of zinc sulphate prepared from zinc carbonate. Write the equation for the reaction involved in the preparation.

....

15. Dry crystals of potassium nitrate were prepared using dilute nitric acid and aqueous potassium hydroxide solution. The steps involved in the preparation are given below but not in correct order :

(*a*) heating the solution in evaporating dish to the point of crystallization.

(*b*) drying the crystals in a dessicator.

(*c*) taking 2ʕ cm^3 of alkali by means of a pipette into a conical flask.

(*d*) adding litmus solution the alkali in the conical flask.

(*e*) cooling the concentrated solution for crystallization.

(*f*) filling a burette with the acid solution.

(*g*) adding the acid drop by drop to the alkali until the litmus just turns red.

Using the letters (*a*), (*b*), (*c*), etc., complete the following sequence to represent the correct order of the various steps :

(*f*) ( ) ( ) ( ) ( ) ( ) (*b*)

16. The set-up of the apparatus for preparing anhydrous iron (III) chloride, $FeCl_3$, is shown in the diagram in the margin :

(*i*) Name the acid which is poured into the flask A. ....

....

(*ii*) What is the solid in flask A ? ....

....

(*iii*) The liquid in bottle B dries the chlorine produced in A. Name the liquid. ....

(*iv*) Write chemical equation for the reaction occurring between heated iron and chlorine.

....

(*v*) Give one test to decide that the dark coloured solid I.S. collecting in the bottle D is an iron (III) compound. ....

....

....

....

(vi) Why is it necessary to dry chlorine ?

17. (a) Explain the reason why an aqueous solution of sodium carbonate is alkaline and that of ammonium chloride is acidic in behaviour.

(b) What is the term for the reaction of a salt with water to form a solution which is either acidic or alkaline ?

(c) Which of the following salts give acidic solutions, alkaline solutions, and neutral solutions in water : potassium nitrate, KNO_3 ; ammonium sulphate, $(NH_4)_2SO_4$; potassium carbonate, K_2CO_3; sodium chloride, NaCl; sodium acetate, CH_3. COONa; and copper sulphate, $CuSO_4$.

(i) Acidic solutions.

(ii) Alkaline solutions.

(iii) Neutral solutions.

18. What is meant by the following terms ; give one example in each case ?

(i) A deliquescent substance.

(ii) A hygroscopic substance.

....

....

(*iii*) An efflorescent substance. ....

....

....

....

19. Fill in the blanks in the following statements :

(1) Vinegar contains .... acid.

(2) The complete reaction between an acid and a base is called ....

(3) As the pH of a solution increases, the .... strength of the solution progressivrely decreases.

(4) As the pH of a solution decreases, its acidic strength progressively. ....

(5) The pH value of a neutral solution is ....

(6) The solution of sodium carbonate is alkaline due to ....

(7) The salts of the acid HNO_2 are called .... and those of the acid HNO_3 are called ....

(8) All acidic solutions contain the .... ions.

(9) All alkaline solutions contain the .... ions.

(10) The formation of a salt from an acid and a base involves the combination of .... from the acid and the .... from the .... to form .... molecules.

□□

ANSWERS

Chapter 1.

1. (1) Matter occupies space, and (2) matter has mass.
2. Material is any particular kind of matter, *e.g.*, iron, water, etc.
3. A homogeneous material has the same properties throughout.
4. A heterogeneous material has different properties in different parts.
5. Homogeneous materials : pure sugar, lemonade, sulphuric acid, and cooking gas. Hetrogeneous materials : smoke, wood and coal.
6. (*a*) Solid, liquid and gas.

   (*b*) A solid has a definite volume and a definite shape. A liquid has a definite volume but no definite shape. A gas has no definite volume and no definite shape.
7. The term 'gas' is used for a substance that is in gaseous state under ordinary conditions. The term 'vapour' is used for the gaseous state of a substance that exists as a liquid or solid under ordinary conditions.
8. (*a*) Freezing (*b*) Sublimation (*c*) Evaporation (*d*) Melting (*e*) Sublimation (*f*) Condensation.
9. (1) By lowering of temperature. (2) By increasing the pressure.
10. Iodine, camphor, ammonium chloride, and solid carbon dioxide.
11. Sublimate.
12. (1) All matter is composed of small particles. (2) The particles are in continuous motion. (3) The particles attract each other with a force which decreases with the increasing distance between them.
13. (*a*) increases (*b*) decreases (*c*) decreases (*d*) increases.
14. (*a*) Solid (*b*) Gaseous.
15. In a solid the particles are closest to one another. So, they attract one another very strongly and remain fixed in their positions.
16. In a gas the particles are very far apart and move about at great speed. So, a gas fills its container completely.
17. By applying pressure the distances between the particles in a gas can be vastly reduced.
18. (*a*) When a solid is heated, its particles vibrate more and more vigorously. At a certain stage they vibrate so vigorously as to break free from one another. This destroys the rigid structure of the solid which melts.

    (*b*) When a liquid is heated, the particles move faster and faster. Some of the faster moving particles escape from the surface of the liquid forming a gas or vapour.

    (*c*) When a gas is cooled, the motion of particles becomes slower. So, the particles come closer and closer. At a certain low temperature, the particles come close enough to form a liquid.

    (*d*) When a liquid is cooled, the speed of the particles further slows down. So, the particles come closer and closer until they are not free to move about. This is the freezing of liquid into solid.

    (*e*) In a solid that sublimes, some of the particles have more kinetic energy than others. Such particles break away from the surface of the solid forming a gas.

19. The two substances can be distinguished by heating them separately. Ammonium chloride sublimes forming white vapour; sodium chloride does not sublime.

20. When ice melts only the structure changes; composition remains the same.

21. The melting point of a solid is the temperature at which it changes into the liquid.

22. The melting point is lowered.

23. It is the temperature at which the change of liquid into vapour is most rapid and steady.

24. The boiling point is increased.

25. (1) F (2) F (3) T (4) T (5) T (6) F (7) T.

Chapter 2.

1. A physical change is a temporary change in which no new substance is formed.
2. A chemical change is a permanent change in which at least one new substance is formed.
3. When sodium chloride is dissolved in water, there occures no change in its composition. On evaporating the solution, the sodium chloride is obtained back. When sodium chloride is dissolved in hot sulphuric acid, its composition is altered. On evaporating the solution, not sodium chloride but a new substance—sodium sulphate—is obtained.
4. (*a*) The weight remains unchanged. (*b*) The weight changes—it may increase or decrease.
5. Heat is taken in for the melting of wax to liquid and the evaporation of molten wax to vapour. Heat is given out in the burning of wax vapour.
6. The physical changes are the melting of wax and the evaporation of the molten wax. The chemical change is the burning of wax vapour.
7. (1) Much heat is given out. (2) A new substance (water) is formed.
8. A chemical change is endothermic if it absorbs heat as it proceeds; exothermic if it liberates heat as it proceeds.
9.

Physical change	*Chemical change*
1. No new substance is formed	1. At least one new substance is formed.
2. Temporary; reversed by removing the cause of change.	2. Permanent; not reversed by removing the cause of change.
3. No change in weight of the substance undergoing change.	3. Weight of substance undergoing change is altered.

10. (1) Heat and light are given out. (2) New substances (carbon dioxide and water are produced). (3) Burnt wax is not re-formed when the candle is put out (*i.e.*, the cause of change is removed.

11. (*a*) Chemical change. Reasons : (1) New substances (sodium hydroxide and hydrogen) are formed. (2) Weight of the residue (sodium hydroxide) obtained after evaporation of solution is more than the weight of sodium.

(*b*) Physical change. Reasons : (1) No new substance is formed. (2) The same weight of sodium chloride is recovered on evaporating the solution.

(*c*) Chemical chang Reasons : (1) A new substance (magnesium oxide) is formed. (2) The weight of the new substance is more than that of magnesium. Or, much heat and light are given out.

(*d*) Physical change. Reasons : (1) No new substance is formed. (2) The change is reversed on cooling (when the ammonium chloride formed in the change changes again to solid ammonium chloride).

(*e*) Physical change. Reasons : (1) No new substance is formed (the composition of water and ice is the same). (2) The change is reversed on heating.

(*f*) Chemical change. Reasons : (1) New substances are formed. (2) The weight of rusted iron is more than that of the iron taken.

(*g*) Chemical change. Reasons : (1) A new substance is formed (rust or hydrated iron (III) oxide. (2) The change is not reversed by removing the cause of it (contact with air and water).

(*h*) Chemical change. Reasons : (1) A new substance (carbonic acid is formed). (2) The change is not reversed when passing carbon dioxide into water is stopped.

(*i*) Chemical change. Reasons : (1) Two new substances (hydrogen and oxygen) are formed. (2) The weight of water progressively decreases as the change occurs.

12. (*a*) Reaction of displacement. (*b*) Reaction of decomposition.
(*c*) Reaction of double decomposition. (*d*) Reaction of combination.
(*e*) Reaction of double decomposition. (*f*) Reaction of combination.
(*g*) Reaction of displacement.

13. (1) $S+O_2 \xrightarrow{\Delta} SO_2$; $CaO+H_2O \xrightarrow{\Delta} Ca(OH)_2$

(2) $2HgO \xrightarrow{\Delta} 2Hg+O_2\uparrow$; $CaCO_3 \xrightarrow{\Delta} CaO+CO_2$

(3) $Zn+H_2SO_4 \longrightarrow ZnSO_4+H_2\uparrow$; $Fe+CuSO_4 \longrightarrow FeSO_4+Cu\downarrow$

(4) $AgNO_3+NaCl \longrightarrow NaNO_3+AgCl\downarrow$ $BaCl_2+H_2SO_4 \longrightarrow 2HCl+BaSO_4\downarrow$

14. (*a*) A photochemical reaction is a chemical change that takes place by the action of light energy.

(*b*) Decomposition of silver chloride into silver and chlorine upon exposure to light.

15. A catalyst is a substance which favours a chemical reaction without itself taking part in it.

16. (*a*) The combination of sulphur dioxide and oxygen in the presence of platinum catalyst to form sulphur dioxide.

(*b*) $2SO_2+O_2 \xrightarrow{Pt} 2SO_3$

17. (*a*) The properties of a substance are its characteristics by which it may be identified.

(*b*) Physical properties and chemical properties.

(*c*) Three important physical properties are : colour, odour, and solubility. Three important chemical properties are : action of heat, action of acids, and action of alkalis.

18. The four properties which alter are : (1) taste, which becomes brackish or salty. (2) melting point, which is lowered, (3) boiling point, which is raised, and (4) specific gravity, which is raised.

19. Melting point, boiling point, and specific gravity.

20. (1) temporary, (2) cannot be, (3) chemical, (4) structure, (5) exothermic (6) endothermic, (7) reactants, (8) displacement, (9) light, (10) precipitate, (11) catalyst, (12) physical.

Chapter 3.

1. (1) Homogeneity, (2) Fixed properties, and (3) Fixed composition.

2. (1) Oxygen is composed of only one kind of atoms. (2) It cannot be broken down into simpler substances. (3) It cannot be formed from simpler substances.

3. (a) Al, Fe, Hg. (b) O_2, H_2, N_2.

4.

	Metals	Non-metals
1.	Possess metallic lustre.	Do not possess metallic lustre.
2.	Good conductors of heat and electricity.	Bad conductors of heat and electricity.
3.	Can be drawn into wires (ductile) or hammered into sheets (malleable).	Cannot be drawn into wire or hammered into sheets.

5. Metalloids are elements having properties midway between those of metals and non-metals. Two examples are arsenic and antimony.
6. A compound is a pure substance made up of two or more elements chemically combined in definite and constant proportion.
7. In water, hydrogen and oxygen are united by chemical force. As a result, their individual identities are totally transformed and water has an entirely new set of properties.
8. The proportion by weight in which the constituent elements of a compound unite is always the same. For example, water always contains 1 part by weight of hydrogen united to 8 parts by weight of oxygen.
9. (a) Analysis (b) Synthesis.
10. Air and lemonade (b) Solid and minerals.
11. An alloy is a homogeneous mixture of two or more metals. An example is brass.

12.

Compounds	Mixtures
1. Homogeneous structure.	1. May be homogeneous or heteogeneous.
2. Definite composition.	2. Variable composition.
3. Properties distinct from those of constituent elements.	3. Properties average of those of the constituents.
4. Contituents cannot be separated by physical means.	4. Constituents can be seperated by physical means.
5. Energy evolved or absorbed during formation.	5. Usually no energy changes during formation.

13. (a) The mixture darkens in colour and the sulphur melts. Then the mixture glows and becomes red-hot. When the glow dies out, a hard lump of a greenish mass is formed.
    (b) Iron (II) sulphide, FeS.
    (c) Exothermic.
    (d) The reaction continues and the mixture becomes red-hot even when external heating is discontinued. This shows that heat is being given out as the reaction proceeds.
14. The two differ in respect of structure, composition, and properties. The structure of iron-sulphur mixture is heterogeneous, that of iron sulphide is homogeneous. The composition of iron-sulphur mixture can be varied, that of iron sulphide is fixed. Iron-sulphur

mixture shows the properties of both of these elements; iron sulphide does not show the properties of either of these elements but has distinct properties of its own.

15. (*i*) Iron sulphide particles sink to the bottom; in iron-sulphur mixture, particles of iron sink and particles of sulphur float on water. (*ii*) Iron sulphide particles do not dissolve; from iron-sulphur mixture, the sulphur particles dissolve leaving behind the Iron particles.

16. (*a*) Iron sulphide dissolves in the acid forming a greenish solution of iron (II) chloride, $FeCl_2$. A colourless gas (hydrogen sulphide) smelling like rotten eggs is evolved. (*b*) A colourless and odourless gas (hydrogen) is evolved with effervescence, and iron particles dissolve leaving behind sulphur particles.

17. (*a*) The composition of water is fixed. The properties of water are different from those of hydrogen and oxygen it is made up of. The costituents of water cannot be separated by physical means.

    (*b*) The composition of air varies with time and place. Air has no distinctive properties of its own, only the average properties of its constituents. The constituents of air can be separated by physical means.

18. (1) The composition of copper and zinc in brass is not fixed and can be varied. (2) In brass, both copper and zinc retain their original properties.

19. (*a*) A is iron, B is sulphur. X is iron sulphide, Y is hydrogen sulphide, S is a solution of iron (II) sulphate, and Z is iron (II) hydroxide.

    (*b*) (*i*) $Fe+H_2SO_4 \longrightarrow FeSO_4+H_2$ (*ii*) $Fe+S \xrightarrow{\Delta} FeS$

    (*iii*) $FeS+H_2SO_4 \longrightarrow FeSO_4+H_2S$ (*iv*) $FeSO_4+2NaOH \longrightarrow Na_2SO_4+Fe(OH)_2$.

    (*c*) (*i*) Reaction of displacement (*ii*) Reaction of combination.

    (*iii*) and (*iv*) Reaction of double decomposition.

20. Its solubility in carbon disulphide.

21. (*a*) Mixture; the composition is variable and constituents can be seperated by physical means. (*b*) Compound ; the composition is fixed and constituents cannot be separated by physical means. (*c*) Element; can neither be created from nor decomposed into still simpler substances. (*d*) Mixture (of CO and N_2); the composition is variable and constituents retain their original proporties (CO burns, N_2 is left behind). (*e*) Compound; reasons as in (b).

22. (*i*) Distillation (*ii*) Separating funnel (*iii*) Sublimation (*iv*) Filtration (*v*) Chromatography (*vi*) Fractional distillation.

23. Chromatography is based on the differences in the extent of adsorption of various substances on the surface of a solid material.

24. (*i*) Fractional distillation (*ii*) Evaporation (*iii*) Distillation (*iv*) Filtration.

25. The mixture is shaken with carbon disulphide in which sulphur dissolves. On filtration, potassium nitrate and carbon are obtained as residue; a solution of sulphur in carbon disulphide is obtained in the filtrate. The filtrate is allowed to evaporate when solid sulphur is deposited.

    The residue of potassium nitrate and carbon is shaken with hot water, in which the former dissolves. On filtration, carbon is obtained as residue; a solution of potassium nitrate in water is obtained as filtrate. The filtrate is concentrated by evaporation and allowed to crystallize. Crystals of potassium nitrate are obtained.

26. (*i*) T (*ii*) F (*iii*) F (*iv*) T (*v*) T (*vi*) F (*vii*) F (*viii*) T (*ix*) F (*x*) T.

Chapter 4.

1. Oxygen, 20 per cent by volume; nitrogen, 79 per cent by volume.
2. Carbon dioxide and water vapour.
3. (*a*) Nitrogen (*b*) The water level will rise approximately one-fifth of the way up the tube. (*c*) When all the oxygen inside the tube has been used up. (*d*) Oxygen; its

reaction is to combine with the burning material to produce new substances with the libration of heat. (e) Phosphorus pentoxide.

4. (a) Water and carbon dioxide. (b) These substances, viz., water and carbon dioxide are formed by the combination of oxygen with hydrogen and carbon respectively present in wax.

5. (a) The flame of the burning candle become progressively dimmer and shorter as the oxygen of the air is used up. Finally, the flame goes out when no more oxygen is left. The inside of the jar becomes misty. This is due to the condensation of water vapour produced by the burning candle. (b) It will turn milky.

6. (a) Burning is a chemical reaction in which substances combine with the oxygen of the air to produce new substances, called oxides, with the libration of much heat and often light.

   (b) Those substances which can burn in air are combustable substances, *e.g.*, wood, coal, and petrol.

   (c) Those substances which cannot burn in air are incombustible substances, *e.g.*, sand, glass and copper oxide.

7. When burnt in air, both magnesium and the carbon in coal combine with oxygen forming magnesium oxide and carbon dioxide respectively. Due to the weight of the combined oxygen, the weight of each product is more. However, carbon dioxide being a gas escapes in air and the coal appears to lose weight.

8. (1) To let in air for the candle to burn. (2) Because oxygen of the air combines with the carbon and hydrogen of the wax in the burning candle to produce carbon dioxide and hydrogen monoxide (water vapour) respectively. (3) To absorb carbon dioxide. (4) By slaking quicklime with sodium hydroxide solution. (5) To absorb water vapour.

9. (a) Respiration and burning both involve combination with oxygen with the liberation of heat. The end-products of both processes are the same—carbon dioxide and water vapour.

   (b) Respiration is a slow process that occurs at body temperature (37°C); burning of candle is a fast process that occurs at a much higher temperature. In respiration energy is released only as heat; in burning energy is released as heat and light both.

10. Respired air has less oxygen but more carbon dioxide and water vapour than the inspired air; the proportion of nitrogen is the same in both.

11. Alkaline pyragallol is introduced inside a long, narrow tube sealed at one end. The mouth of the tube is closed with a rubber stopper. The tube is held vertically upside down and the length of air column inside the tube measured. The tube is inverted several times and then inverted in a jar of water. The stopper is removed when the water rushes in to take the place of oxygen absorbed by alkaline pyragallol. The length of the column of remaining air is measured after equalising the level of water inside the tube.

12. Carbon dioxide and water vapour. Carbon dioxide is identified by its property of turning lime water milky. Water vapour is identified by its property of turning anhydrous calcium chloride into a sticky mass.

13. (a) Anhydrous calcium chloride, anhydrous zinc chloride, phosphorus pentoxide, and quicklime. (b) Concentrated sulphuric acid.

14. (a) Helium, neon, argon, krypton, and xenon. (b) Because these gases do not combine with other elements.

15. (a) (1) The composition of air changes slightly from place to place, from time to time, and with altitude. (2) The components of air can be separated by physical means. (3) Liquid air has no definite boiling point.

16. (1) The burning substance combines with the oxygen of the enclosed air. Water rises to take the place of the oxygen removed.

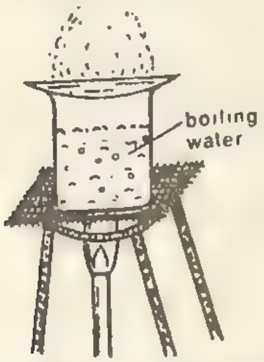
    (2) The water vapour produced by the burning candle condenses on the cold surface of the glass forming a mist of water droplets.

    (3) During respiration air is used up and carbon dioxide and water vapour are formed (by the combination of oxygen with the carbon and hydrogen in the food).

(4) Nitrogen does not take part in the process of respiration.
(5) Lime water reacts with carbon dioxide to produce white particles of insoluble calcium carbonate.
(6) Anhydrous calcium chloride absorbs moisture from air.
(7) Air is a mixture of mainly oxygen and nitrogen, and oxygen is more soluble in water than nitrogen.
(8) When strongly heated, potassium nitrate decomposes giving off oxygen needed for burning.

Chapter 5.

1. Water has maximum density at 4°C. Frozen water or ice is at a temperature of 0°C, and is lighter than water at 4°C. So, fish remain alive in the denser water at 4°C under the layer of frozen water.
2. (*a*) The boiling point is raised. (*b*) The freezing point is lowered.
3. Water has a higher specific heat, 1 calorie per gram per degree at 15°C, than any other solid or liquid substance.
4. (1) Freshly distilled water is free from dissolved gases and solids; ordinary tap water has dissolved air and solid substances both. (2) Fresh water freezes at 0°C, tap water freezes below 0°C. (3) Fresh water boils at a lower temperature than ordinary tap water.
5. The sample of water is taken in large, clean clock-glass. It is allowed to evaporate slowly by placing the clock-glass over a beaker containing gently boiling water. Distilled water leaves behind no residue of solid material; spring water leaves behind concentric rings of solid material.
6. (*a*) A larger clock-glass is filled with tap water. It is placed over a beaker containing gently boiling water. The water slowly evaporates by the heat provided. When all



the water has evaporated, several concentric rings of solid material are seen on the clock glass. These are the solids that were dissolved in the water.

(*b*) (1) Fresh distilled water has a flat taste; tap water has a pleasant taste. (2) Fresh distilled water is free from dissolved mineral matter; tap water has dissolved minerals in it.

7. (1) The liquid is slowly evaporated to dryness in a clock-glass. Pure water leaves no residue: the solution leaves a white residue of the salt. (2) The boiling points of the liquid and of freshly distilled water are determined. If the two boiling points are the same, the liquid is pure water. If the liquid has a higher boiling point than distilled water, it is a solution. (3) The density of the liquid is determined. If it is over 1 g cm^{-3} the liquid is a solution; density of pure water is never more than 1g cm^{-3}.
8. (*a*) A *solution* is a homogeneous mixture of a solid substance in a liquid the composition of which may be varied continuously up to a certain limit with respect to the maximum amount of the solid in a given volume. (*b*) *Solute* is the substance that dissolves in a liquid to form a solution. *Solvent* is the liquid that dissolves a substance to form a solution. (*c*) A *tincture* is a solution in which the solvent is alcohol.

9. (*a*) In a solution the solute exists as particles of molecular size or smaller. These particles are too small to be retained in the pores of filter paper. (*b*) The particles of solute keep moving throughout the solution and are uniformly distributed in the entire volume.

10. A solution has no definite proportion by weight, and its composition can be varied. Also, it has no specific properties of its own and retains the properties of its components.

11. The use of the term 'saturated' means that the solution will not dissolve any more of the salt at that temperature.

12. An unsaturated solution is a solution in which more of the solute can dissolve at that very temperature.

13. A small crystal of the salt is added to the solution which is then vigorously stirred. If the crystal does not dissolve, the solution is saturated; if it dissolves, the solution is unsaturated.

14. (*a*) Solubility of a solid is its weight in grams that will saturate 100 grams of water, at a given temperature.
(*b*) The statement means that at 45°C 54 grams of potassium nitrate will dissolve in 100 grams of water to make a saturated solution.

15. (*a*) Type I : Potassium nitrate and copper sulphate; Type II : Sodium chloride and potassium chloride; Type III : Calcium sulphate and calcium hydroxide.
(*b*) Solubilities of salts usually increase with increase of temperature.

16. (*a*) Crystals of potassium nitrate are gradually deposited.
(*b*) The amount of potassium nitrate that dissolves in a given weight of water at 50°C is much more than the amount that dissolves at room temperature. The additional amount of potassium nitrate separates as crystals as the solution is cooled.

17. (1) Grinding the solid to a fine powder. (2) Stirring the powdered solid and the liquid. (3) Heating the liquid.

18. Powdered potassium nitrate is added in sufficient quantity to water being heated to about 60°C so that some of it remains undissolved. The solution is then allowed to cool. As soon as the temperature falls to 50°C, about 20 cm^3 of the solution is decanted into a weighed China dish. The dish is again weighed. The solution is then evaporated to dryness, and the dish with the residue weighed after cooling in a dessicator. From the weights of the solution and the residue obtained is calculated the solubility of potassium nitrate.

19. A solubility curve is a graph that shows the variation of solubility with temperature. It is plotted from the solubilities at the various temperatures representing the solubilities along the ordinate and the temperatures along the abcissa.

20. (1) The shape of the curve indicates the rate of change in solubility with rise in temperature. (2) It permits determination of solubility of the substance at any given temperature.

21. 136 g of saturated solution at room temperature contains 36 g of common salt. Therefore, 340 g of saturated solution will contain $\frac{36\text{ g}}{136\text{ g}} \times 340\text{ g} = 90\text{ g}$ of common salt.

22. The solution of the impure substance is saturated with respect to the principal substance but is unsaturated with respect to the impurities which are present in much smaller quantities. Hence, only the principal substance separates as crystals and the impurities are left behind.

23. Crystalline : sodium chloride, copper sulphate ; Amorphous : chalk, charcoal.

24. (*a*) Water of crystallization is the water chemically combined in a definite molecular proportion with a crystalline substance. (*b*) The crystals are heated in a test tube fitted with a delivery tube. Water of crystallization in the crystals is set free as steam. The steam passing through the delivery tube cools and condenses to give pure water.

25. (*a*) The term hydrated means that the compound contains a definite amount of water of crystallization. (*b*) The dot signifies that the five molecules of water are only loosely combined with one molecule of copper sulphate.

26. A few crystals of the salt are heated in a dry test tube. If a film of moisture, or droplets

of water, appear on the upper cool portion of the test tube, the salt contains water of crystallization.

27. The colourless liquid is put in contact with anhydrous copper sulphate (white). It turns blue showing that the liquid is water.

28. (*a*) *Observation* : Droplets of a colourless liquid appear on the upper part of the test tube. The crystals lose colour and crumble to a white amorphous powder. When the colourless liquid is put in contact with the white residue (anhydrous copper sulphate), it again becomes blue

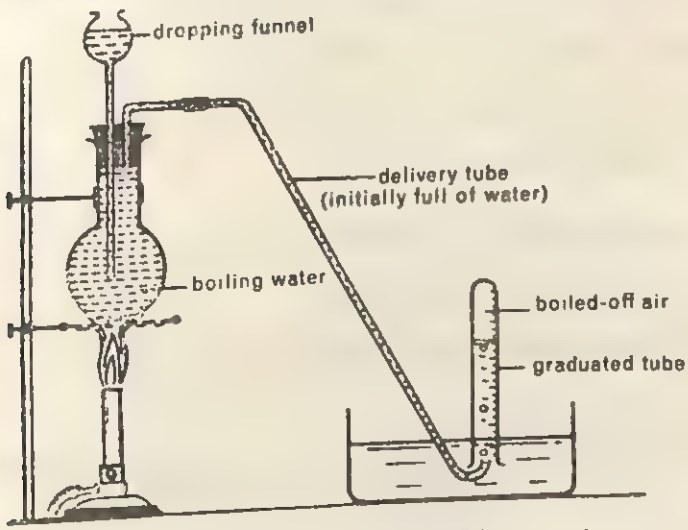
Inferences : Copper sulphate crystals contain water of crystallization and to it they owe their colour and crystalline shape.

(*b*) $CuSO_4.5H_2O \xrightarrow{\Delta} CuSO_4 + 5H_2O\uparrow$

(*c*) Barium chloride dihydrate, $BaCl_2.2H_2O$, iron (II) sulphate heptahydrate, $FeSO_4.7H_2O$, and sodium carbonate decahydrate, $Na_2CO_3\ 10H_2O$.

29. The crystals turn into a powdery substance on the surface. This behaviour is called efflorescence. It is caused by the loss of whole or part of the water of crystallization.

30. (*a*) A round-bottom flask fitted with a delivery tube is completely filled with tap water. The delivery tube leads to a water-filled graduated tube inverted over water in a trough. The water in the flask is boiled when air dissolved in it is driven out. This air collects in the graduated tube by displacement of water.



(*b*) The air dissolved in water contains about 34 per cent oxygen and 66 per cent nitrogen; ordinary air contains about 21 per cent oxygen and 78 per cent of nitrogen.

(*c*) The oxygen of the air dissolved in water is used by most kinds of fish for respiration. Carbon dioxide of the air dissolved in water is used by water plants for photo-synthesis.

31. (*a*) The solubility of gases decreases as the temperature rises and increases as the pressure is increased, and vice versa.

(*b*) Soda-water contains carbon dioxide dissolved in water under 5—10 atm pressure. When the bottle is opened the pressure is reduced to 1 atm. So, dissolved carbon dioxide escapes with a fizz.

32. (*a*) The piece of sodium melts into a shining globule by the heat of the reaction. The globule skates about on the surface of water giving off hydrogen gas with a hissing sound. and becomes smaller and smaller. Finally, it breaks up with a small explosion and disappears. The water feels soapy to touch and turns red litmus blue.

$$2Na + 2H_2O \rightarrow 2NaOH + H_2\uparrow$$

(b) Calcium metal sinks to the bottom and reacts with water producing bubbles of hydrogen. The water soon turns cloudy due to the formation of sparingly soluble calcium hydroxide. The milky liquid turns red litmus blue.

$$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2\uparrow$$

(c) Magnesium catches fire and burns brightly forming a white powder (magnesium oxide). Hydrogen is given off which can be made to burn with a pale-blue flame.

$$Mg + H_2O \longrightarrow MgO + H_2\uparrow$$

33. (a) Iron heated red-hot, and water in the form of steam. (b) Triferric tetroxide, Fe_3O_4. (c) $3Fe+4H_2O \rightleftharpoons Fe_3O_4+4H_2$ (d) Because the product, triferric tetroxide and hydrogen can react at that very temperature to give the original substances, iron and steam. (e) This reaction is reversible; the reaction between heated magnesium and steam is non-reversible.

34. (1) It has no dissolved air or carbon dioxide. (2) 4°C. (3) solids. (4) the solute exists as particles of molecular size or smaller which cannot be seen. (5) mother liquor. (6) anhydrous (7) efflorescence (8) oxygen (9) sodium hydroxide (10) calcium hydroxide

Chapter 6 :

1. (1) Mercuric oxide ; $2HgO \xrightarrow{\Delta} 2Hg + O_2\uparrow$

   (2) Potassium chlorate ; $2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2\uparrow$

   (3) Hydrogen peroxide ; $2H_2O_2 \xrightarrow{\Delta} 2H_2O + O_2\uparrow$

2. (1) $2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2\uparrow$

   (2) $2Pb_3O_4 \xrightarrow{\Delta} 6PbO + O_2\uparrow$

3. (a) (1) Mercuric oxide : $2HgO \xrightarrow{\Delta} 2Hg + O_2\uparrow$

   (2) Silver oxide : $2Ag_2O \xrightarrow{\Delta} 4Ag + O_2\uparrow$

   (b) (1) Lead (II, IV) oxide : $2Pb_3O_4 \xrightarrow{\Delta} 6PbO + O_2\uparrow$

   (2) Lead (IV) oxide : $2PbO_2 \xrightarrow{\Delta} 2PbO + O_2\uparrow$

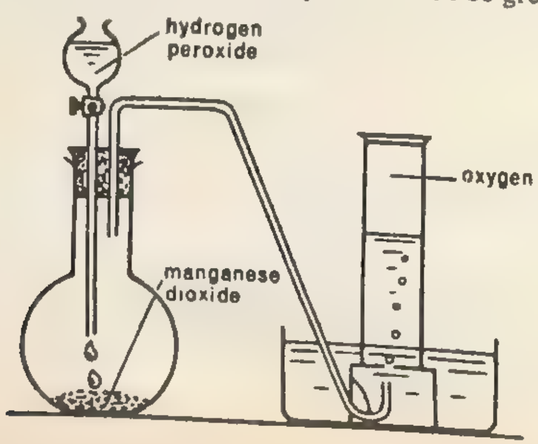
4. (a) A catalyst is a substance which alters the rate of a chemical reaction by its mere presence, *i.e.*, without itself undergoing any chemical change.

   (b) Manganese dioxide, MnO_2. (c) $2H_2O_2 + [MnO_2] \longrightarrow 2H_2O + O_2\uparrow + [MnO_2]$.

   (d) By the downward displacement of water.

   (e) The rate of evolution of hydrogen peroxide will be greatly decreased.

5. (a)



(*b*) Manganese dioxide is placed in a flat-bottom flask, and the apparatus set up as shown in the labelled diagram. '20 volume' hydrogen peroxide is dropped at a controlled rate on the manganese dioxide. Oxygen evolved is collected in gas jars by one downward displacement of water.

(*c*) Oxygen is first passed through anhydrous calcium chloride and then collected over mercury.

6. (*a*) Potassium chlorate is mixed with about one-quarter of its weight of manganese dioxide. The mixture is heated in a hard-glass tube. The oxygen evolved is collected in gas jars by downward displacement of air.

(*b*) Oxygen is more soluble in water than nitrogen.

(*c*) (*i*) Hydrogen : $2H_2 + O_2 \rightarrow 2H_2O$.

(*ii*) Carbon monoxide : $2CO + O_2 \rightarrow 2CO_2$.

7. (*a*)

Substance	*Observation*	*Equations for reactions with oxygen and of product with water*	*Action of Litmus*	
			Blue	*Red*
Carbon	Burns brightly producing a colourless gas (CO_2)	(*i*) $C+O_2 \rightarrow CO_2$ (*ii*) $CO_2+H_2O \rightarrow H_2CO_3$	Turns wine red	×
Sodium	Burns with a bright yellow flame producing a white solid (Na_2O_2)	(*i*) $2Na+O_2 \rightarrow Na_2O_2$ (*ii*) $2Na_2O_2+2H_2O \rightarrow 4NaOH+O_2$	×	Turns blue
Phosphorus	Burns brightly producing white fumes (P_2O_5)	(*i*) $4P+SO_2 \rightarrow 2P_2O_5$ (*ii*) $P_2O_5+3H_2O \rightarrow 2H_3PO_4$	Turns red	×
Sulphur	Burns brightly giving off a colourless, pungent gas (SO_2)	(*i*) $S+O_2 \rightarrow SO_2$ (*ii*) $SO_2+H_2O \rightarrow H_2SO_3$	Turns red	×
Calcium	Burns brightly with a brick red flame forming a white solid (CaO)	(*i*) $2Ca+O_2 \rightarrow 2CaO$ (*ii*) $CaO+H_2O \rightarrow Ca(OH)_2$	×	Turns red

(*b*) Non-metal elements burn in oxygen to form oxides which dissolve in water to give acid solutions ; metal elements burn in oxygen to form oxides which dissolve in water to give basic solutions.

(*c*) Hydrogen, a non-metal element, forms a neutral oxide. Oxides of many metals, *e.g.*, iron, are insoluble in water and do not form basic solutions.

8. (1) For patients suffering from asthma, pneumonia, etc. Mixture of oxygen and nitrous oxide is used as anaesthetic in dental surgery.

(2) In oxy-hydrogen and oxy-acetylene flames for cutting and welding metals, and in the production of iron and steel.

(3) In the production of nitric acid from ammonia, and in the manufacture of linoleum, varnishes, etc.

9. (*a*) Chemically iron rust is hydrated iron (III) oxide, $Fe_2O_3.xH_2O$.

(*b*) Iron rust is flaky and drops off exposing the underlying metal to the conditions for rusting.

(*c*) Air (oxygen) and water.

(*d*) Clean iron nails are placed in dry air, air-free water, and ordinary water which contains dissolved air. Rusting occurs only in the last case.

(*e*) (1) By applying an oil paint. (2) By baking enamel on the surface. (3) By covering with a thin layer of tin (tin-plating), zinc (galvanizing), chromium, cadmium, or nickel.

10. (*a*) By applying oil paints. (*b*) By enamel coating. (*c*) By coating with tin. (*d*) By coating with zinc. (*e*) By coating with nickel, chromium, or cadmium.

11. (*i*) An acidic oxide is a compound made up of an element and oxygen which combines with water to form an acid and reacts with alkalis to give a salt and water, *e.g.*, sulphur dioxide.

$$SO_2 + H_2O \rightarrow H_2SO_3 \text{ (sulphurous acid)} ; \quad SO_2 + 2NaOH \rightarrow \underset{\text{(sod. sulphite, salt)}}{Na_2SO_3} + H_2O.$$

(*ii*) A basic oxide is a compound made of a metal element and oxygen which reacts with acids to produce salt and water, *e.g.*, copper (II) oxide.

$$CuO + H_2SO_4 \longrightarrow \underset{\text{(copper sulphate, salt)}}{CuSO_4} + H_2O$$

12. (1) The statement means that carbon dioxide will combine with water to form an acid (it forms carbonic acid, H_2CO_3) and will neutralize alkali solutions to form salts (the carbonate salts) and water.

(2) The statement means that magnesium oxide will neutralize acids to form magnesium salts (*e.g.*, magnesium chloride) and water.

13. (*a*) (1) Carbon, CO_2; (2) Sulphur, SO_2; (3) Phosphorus, P_2O_5.
(*b*) (1) Sodium, Na_2O_2; (2) Magnesium, MgO; (3) Calcium, CaO.

14. (1) CO_2; (2) SO_2; (3) P_2O_5; (4) Fe_2O_3; (5) CuO; (6) Na_2O_2

15. (1) A neutral oxide is an oxide which shows neither acidic nor basic properties, *e.g.*, water (H_2O) and carbon monoxide (CO).

(2) An amphoteric oxide is an oxide that shows both acidic and basic properties and reacts with alkalis and acids both to form salts and water, *e.g.*, zinc oxide (ZnO) and aluminium oxide (Al_2O_3).

16. (1) Acidic oxides : P_2O_5, CO_2, SO_3 (2) Basic oxides : CuO, CaO, MgO, Fe_2O_3
(3) Neutral oxides : H_2O, CO (4) Amphoteric oxide : ZnO

17. Zinc oxide, ZnO. As a basic oxide it reacts with acids to form salts and water ; as an acidic oxide it reacts with alkali solutions to form salts and water.

$$ZnO + H_2SO_4 \longrightarrow ZnSO_4 + H_2O \quad \text{(behaviour as basic oxide)}$$
$$ZnO + 2NaOH \longrightarrow Na_2ZnO_2 + H_2O \quad \text{(behaviour as acidic oxide)}$$

18. (1) Sulphur dioxide is passed through water. The solution formed is separately tested with red litmus paper and blue litmus paper. The blue litmus paper turns red; red litmus paper is not affected.

(2) Copper (II) oxide is shaken separately with sodium hydroxide solution and sulphuric acid. It does not dissolve in sodium hydroxide solution but dissolves in sulphuric acid to give deep blue solution. The solution deposits crystals of the salt copper sulphate, $CuSO_4$.

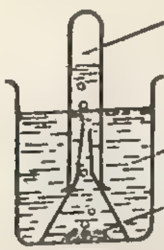
19. (1) An acid anhydride is an oxide so termed because it can be represented as acid *minus* water, *e.g.*, sulphur dioxide, SO_2 is termed sulphurous anhydride (sulphurous acid, H_2SO_3 *minus* water H_2O : $H_2SO_3 - H_2O = SO_2$).

(2) An alkali is a soluble hydroxide, *e.g.*, calcium hydroxide, $Ca(OH)_2$. Basic oxides which dissolve in water form alkalis, *e.g.*, $CaO + H_2O \longrightarrow Ca(OH)_2$.

20. (1) Each oxide is separately shaken with sodium hydroxide solution; magnesium oxide does not dissolve, zinc oxide dissolves.
(2) Each oxide is separately dissolved in water and the solutions tested with blue and red litmus papers. Solution of acidic oxide turns blue litmus red, of basic oxide burns red litmus blue.
21. The mixture is heated with sodium hydroxide solution. The amphoteric zinc oxide dissolves; the basic copper (II) oxide does not. On filtration, copper (II) oxide is obtained as residue.
22. (*a*) Phosphorus pentoxide, P_2O_5 :
(*i*) $P_2O_5 + 6NaOH \longrightarrow 2Na_3PO_4 + 3H_2O$, (*ii*) No reaction. Acidic.
(*b*) Water (hydrogen monoxide), H_2O :
(*i*) No reaction. (*ii*) No reaction. Neutral.
(*c*) Magnesium oxide, MgO :
(*i*) No reaction. (*ii*) $MgO + 2HCl \rightarrow MgCl_2 + H_2O$. Basic.
23. (1) manganese dioxide, (2) catalyst, (3) higher, (4) water, (5) amphoteric, (6) air, water, (7) acidic, neutral.

Chapter 7.

1. (1) Sodium and calcium, (2) Magnesium and zinc, (3) Zinc and iron, (4) Zinc and aluminium.
2. Copper, silver, and mercury.
3. Calcium > Magnesium > Zinc > Tin.
4. (a) A is zinc, B is dilute hydrochloric acid.
(*b*) $Zn + 2HCl \longrightarrow ZnCl_2 + H_2\uparrow$
(*c*) (*i*) The reaction between sodium and water gives hydrogen but is too vigorous. (*ii*) Copper does not displace hydrogen from acids. (*iv*) Sodium peroxide and water react to give oxygen and not hydrogen.
(*d*) Water.
(*e*) Downward displacement of water.
(*f*) When a lighted splint is introduced in hydrogen, the splint is extinguished and the gas burns with an almost invisible pale-blue flame.
5. (*a*)



(*b*) A squeaky explosion will occur.

6. (*a*) By adding zinc to dilute acid. $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2\uparrow$
(*b*) By boiling zinc with a concentrated solution of alkali.
$$Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2\uparrow$$
(*c*) By passing steam over red hot iron. $3Fe + 4H_2O \rightleftharpoons Fe_3O_4 + 4H_2\uparrow$
7. (*a*) $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2\uparrow$
(*b*) By adding a little copper sulphate to the reaction mixture.
(*c*) By passing hydrogen through anhydrous calcium chloride and then collecting it over mercury.

(*d*) For the production of '*Vanaspati Ghee*' by hydrogenation of oils and for making petrol from coal.

8. (*a*) Sodium is much more reactive than zinc. As such, its reacts so vigorously with dilute hydrochloric acid that an explosion occurs.

(*b*) Hydrogen is inflammable and catches fire. Furthermore, it forms an explosive mixture with air.

(*c*) (*i*) $2H_2 + O_2 \longrightarrow 2H_2O$.

(*ii*) Because the temperature of the flame is higher than 100°C.

(*iii*) (1) The liquid is added to anhydrous copper sulphate (white) which turns blue.

(2) Sodium is added to the liquid. Hydrogen evolves ; the liquid when tested with red litmus paper turns it blue.

(*d*) When hydrogen is passed over heated copper (II) oxide, it takes away the oxygen of the oxide leaving behind copper. $CuO + H_2 \longrightarrow Cu + H_2O$.

9. (*a*) Water gas is a mixture of carbon monoxide (CO) and hydrogen in nearly equal volumes. (*b*) Water gas is made by passing steam through a layer of white hot coke. $C + H_2O \longrightarrow CO + H_2$. (*c*) Water gas is mixed with even steam and passed over hot iron oxide catalyst. Carbon monoxide of water gas reacts with steam to form carbon dioxide and hydrogen ($CO + H_2O \rightarrow CO_2 + H_2$). Carbon dioxide is removed by forcing the mixture under pressure through water; carbon dioxide dissolves leaving hydrogen. (*d*) Bosch Process.

10. (*a*) Hydrogen continues to burn forming colourless, pungent-smelling hydrogen chloride gas. (*b*) Drops of water are formed at the cold surface. (*c*) The black copper (II) oxide changes to reddish brown copper metal and water is produced.

11. (1) When hydrogen is passed through boiling sulphur. The product is hydrogen sulphide. $H_2 + S \rightarrow H_2S$. (2) High pressure, low temperature, and finely divided iron as catalyst. $N_2 + 3H_2 \rightarrow 2NH_3$. Exposure of a mixture of hydrogen and chlorine to sunlight or burning of hydrogen at a jet in a jar of chlorine. $H_2 + Cl_2 \rightarrow 2HCl$. (4) Heating calcium in hydrogen gas.

$$Ca + H_2 \xrightarrow{\Delta} CaH_2.$$

12. (*a*) The oxides are reduced to respective metals, viz., iron, lead, and copper.

(*b*) 1. $Fe_2O_3 + 3H_2 \rightarrow 2Fe + 3H_2O$. 2. $CuO + H_2 \longrightarrow Cu + H_2O$

3. $PbO + H_2 \longrightarrow Pb + H_2O$. (*c*) Reduction.

13. (*a*) A is iron (III) oxide, B is iron, C is water, (*b*) 1. Determine density. 2. Determine boiling point.

14. (*a*) Because hydrogen is so light that it has a lifting effect of thirteen times its own weight. (*b*) 1. Ammonia, 2. Hydrogen chloride. (*c*) (*i*) Powdered coal reacts with hydrogen under pressure in the presence of suitable catalysts. The product is a mixture of liquid compounds which can be used as petrol. (*ii*) Decolorized and deodorized vegetable oils are heated with hydrogen under pressure in the presence of nickel catalyst. This converts the oils into a ghee like product called Vanaspati Ghee.

15. (1) Oxidation is a chemical change in which a substance either gains oxygen or loses hydrogen. (2) Reduction is a chemical change in which a substance either loses oxygen or gains hydrogen. (3) When hydrogen is passed over heated copper (II) oxide, copper metal and water are formed : $CuO + H_2 \longrightarrow Cu + H_2O$. In this reaction, hydrogen gains oxygen and copper (II) oxide loses oxygen. Hence, hydrogen undergoes oxidation and copper (II) oxide undergoes reduction.

16. (1) CO oxidized; it gains oxyyen. Fe_2O_3 reduced; it loses oxygen. (2) C oxidized; it gains oxygen. H_2O reduced; it loses oxygen. (3) H_2S oxidized; it loses hydrogen. Cl_2 reduced; it gains hydrogen. (4) CO oxidized; it gains oxygen. PbO reduced; it loses oxygen. (5) H_2S oxidized; it loses hydrogen, SO_2 reduced; it loses oxygen.

17. (1) When carbon burnt in air, it combines with oxygen to form carbon dioxide, CO_2 : $C+O_2 \longrightarrow CO_2$. (2) When hydrochloric acid is heated with manganese dioxide, it loses hydrogen to yield chlorine : $MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2\uparrow$.

(3) When copper (II) oxide is heated with carbon, it loses oxygen to give free copper : $CuO + C \longrightarrow Cu + CO$. (4) Chlorine combines with hydrogen to give hydrogen chloride : $Cl_2 + H_2 \longrightarrow 2HCl$.

18. (*a*) 1. Carbon monoxide, CO. 2. Sulphur dioxide, SO_2.
(*b*) 1. $PbO + CO \longrightarrow Pb + CO_2$. 2. $SO_2 + Cl_2 + 2H_2O \longrightarrow 2HCl + H_2SO_4$.
(*c*) 1. Water (steam), H_2O. 2. Nitric acid, HNO_3.
(*d*) 1. $C + H_2O \longrightarrow CO + H_2$. 2. $C + 4HNO_3 \longrightarrow 2H_2O + 4NO_2 + CO_2$.

19. (*a*) 1. Chlorine, Cl_2 (g). 2. Nitric acid, HNO_3. 3. Manganese dioxide, MnO_2 (s).
(*b*) 1. $Cl_2 + H_2S \longrightarrow 2HCl + S$. 2. $2HNO_3 + 3H_2S \longrightarrow 3S + 4H_2O + 2NO$.
3. $MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$.
(*c*) 1. Carbon monoxide, CO (g). 2. Sulphurous acid, H_2SO_3 (l). 3. Carbon, C (s).
(*d*) 1. $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$. 2. $H_2SO_3 + H_2O + Cl_2 \longrightarrow 2HCl + H_2SO_4$.
(*e*) 1. Chlorine, nitric acid, steam. 2. Hydrogen, ammonia.

20. (1) F (2) F (3) T (4) T (5) F (6) T (7) F (8) T (9) T (10) F*.

Chapter 8.

1. (*a*) (*i*) Mass=1, charge=+1 (*ii*) Mass=0 ; charge=−1. (*iii*) Mass=1, charge=0.
(*b*) Protons and neutrons are located in a body called nucleus at the centre of the atom. Electrons are distributed in the region around the nucleus.

2. Atomic mass unit is equal to the ratio of the weight of an atom or subatomic particle to the weight of 1/12 fraction of the atom of carbon whose weight is taken to be 12·000.

3. The charges on proton and electron are of equal magnitude but opposite sign, viz. +1 and −1 respectively. In any atom the number of protons is equal to the number of electrons. Hence, the total posititive charge due to protons is equal to the total negative charge due to electrons, whereby the atom is electrically neutral.

4. (*a*) 1. Atomic number is a number equal to the number of protons in the nucleus and the number of electrons around it. 2. Mass number is the number of protons plus the number of neutrons in the nucleus.
(*b*) Mass number gives the mass of the nucleus and is slightly less than the atomic weight which is the total weight due to protons, neutrons, and electrons.

5. (*a*) There are 12 protons in the nucleus of magnesium atom and 12 electrons in the region around the nucleus.
(*b*) The total weight of the protons and neutrons in the nucleus of magnesium atom is 24 amu.

6. (1) 4. (2) 9.

7. (*a*) An electron orbit is the path of an electron around the nucleus of an atom.
(*b*) Electron orbits are designated by whole numbers 1, 2, 3, 4, 5, 6, and 7 or by capital letters K, L, M, N, O, P, and Q respectively extending outward from the nucleus.
(*c*) Because an electron continues to move indefinitely in its orbit without any loss of energy. (*d*) The energies of electrons in various orbits in the atom increase with the increasing distance of the orbit from the nucleus.

8. (*a*) By electronic configuration is meant the number of electrons in various shells around the nucleus. (*b*) (1) 2, 8, 1. (2) 2, 8, 6.

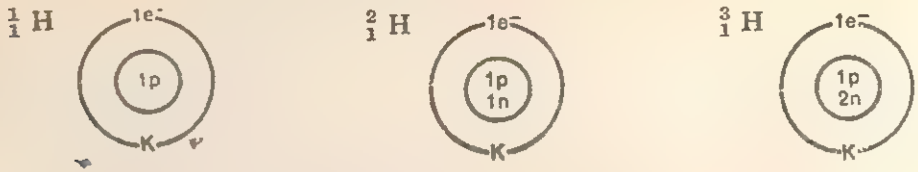
9. (*a*) The maximum number of electron in the *n*th shell outward from the nucleus is $2n^2$.
(*b*) 8.

10. (1) 40, (2) 20, (3) 2, 8, 8, 2, (4) 20 protons and 20 neutrons.

11. (1) The subscript represents the atomic number, *i.e.*, the number of protons in the nucleus and the number of orbital electrons. The superscript denotes the total number of protons

*When oxygen combines with hydrogen to form water, it is reduced.

and neutrons in the nucleus or the mass of the nucleus in atomic mass unit. (2) The change in the superscripts is accounted by the different number of neutrons in the nuclei of these atoms. (3) Isotopes.



12. (*a*)

Mass Number	*Protons*	*Electrons*	*Neutrons*
35	17	17	18
37	17	17	20

(*b*) The two isotopes have the same number of protons and the same number of electrons.

(*c*) Cl-37 has two more neutrons in the nucleus than Cl-35. (*d*) Isotopes.

13.

Element	*Mass Number*	*Atomic Number*	*Number of Protons*	*Number of Neutrons*	*Electronic configuration*
Potassium	39	19	19	20	2, 8, 8, 1
Phosphorus	31	16	15	16	2, 8, 5

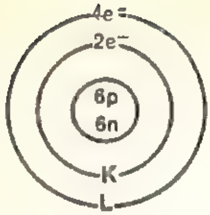
14. (1) The chemical properties of atoms are determined by the number and arrangement of the orbital electrons. Isotopes have the same number of orbital electrons (17 for $^{35}_{17}Cl$ and $^{37}_{17}Cl$ both). Hence, the isotopes have identical chemical properties.

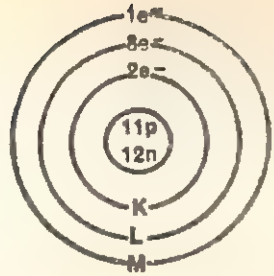
(2) Ordinary chlorine consists of the isotopes $^{35}_{17}Cl$ and $^{37}_{17}Cl$ in the proportion of nearly 3 : 1. Hence, the relative atomic mass of ordinary chlorine is

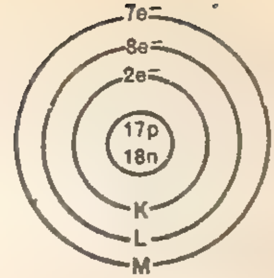
$$\frac{(3\times35)+(1\times37)}{4}=\frac{142}{2}=35{\cdot}5,$$

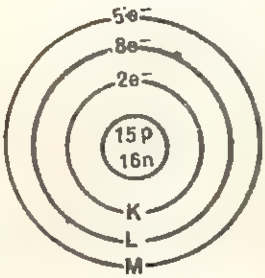
and not a whole number.

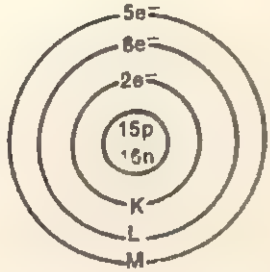
15. Elements are characterized by a definite set of chemical properties which are determined by the number and arrangement of orbital electrons in their atoms. The two isotopes of chlorine have the same number and arrangement of orbital electrons in their atoms and hence the same chemical properties. Therefore, they are one element and not different elements.

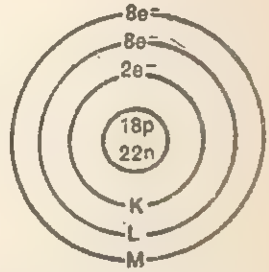
16. $^{12}_{6}C$ 

$^{23}_{11}Na$ 

$^{35}_{17}Cl$ 

17. $^{30}_{17}P$ 

$^{31}_{15}P$ 

$^{40}_{18}Ar$ 

18. (a) Because as part of the molecules, the atoms are in more stable forms.
(b) Atoms combine to form molecule by the rearrangement of their outers-hell electrons.

19. (a) The chracteristic feature is the presence of eight electrons in their outermost shells.
(b) An atom tends to form an ion by gaining or losing one or more electrons to acquire a stable form consisting of 8 electrons in the outermost shell. Chlorine has the electronic configuration 2, 8, 7. It acquires the stable form by gaining 1 electron to form Cl^- which has the electron configuration 2, 8, 8. Potassium has the electron configuration 2, 8, 8, 1. It acquires the stable form by losing 1 electron to form K^+ which has the electron configuration 2, 8, 8. Argon has the electron configuration 2, 8, 8 which is a stable form by itself. So, it forms neither a positive ion nor a negative ion.

20. (a) An ion is an atom or a group of atoms which has acquired electrical charge by the loss or gain of one or more electrons.
(b) An electrovalent bond is formed by the transfer of electrons from one atom to another. The atom which loses electrons becomes positive ion, the atom which gains electrons becomes negative ion. The electrostatic attraction between the oppositely charged ions holds them together and constitutes the electrovalent bond. For example, when sodium and chlorine combine, each sodium atom loses one electron to form Na^+ ion and each chlorine atom gains one electron to form Cl^- ion. These ions are held together by the electrovalent bond.

21. (a) A covalent bond is formed between two atoms by the sharing of a pair of electrons, one being provided by each atom.
(b) (i) A single covalent bond is a bond formed by one shared pair of electrons between two combining atoms. A double covalent bond is set up by two shared pairs of electrons, and a triple covalent bond by the sharing of three pairs of electrons.
(ii) Examples of molecules containing single covalent bond, doubie covalent bond, and triple covalent bond are the hydrogen molecule, H—H, the oxygen molecule, O=O, and the nitrogen molecule, N≡N, respectively.

22. Compounds formed by electrovalent bonds consist of oppositely charged ions ; those formed by covalent bonds consist of separate molecules.

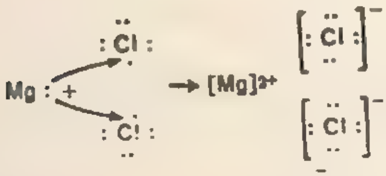
23. (a) Because electrovalent compounds consist of oppositely charged ions.

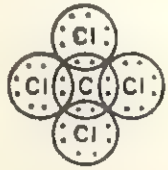
(*b*) Because covalent compounds consist of separate molecules.

24. (*a*) sign and charge = + 1 ;
(*b*) X will have reducing properties as it can readily lose the single electron from its outermost shell to form the ion X^+ ($X \rightarrow X^+ + e^-$).

25. (*a*) $Na \longrightarrow Na^+ + e^-$, $Cl + e^- \longrightarrow Cl^-$, $Na^+ + Cl^- \longrightarrow Na^+ Cl^-$.

(*b*) Na· + ·Cl: → [Na]+ [:Cl:]−

26. (*a*) 

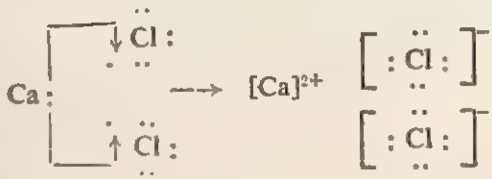
(*b*) ·C + 4·C: → 

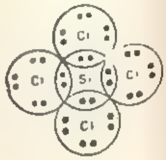
27. (*a*) E, (*b*) 12, (*c*) (*i*) A and B ; B and C. (*ii*) AB_2 (A^{2+}, B^-) and CB (C^+, B^-),

(*d*) Covalent bond, (*e*) DB_4, (*f*) 

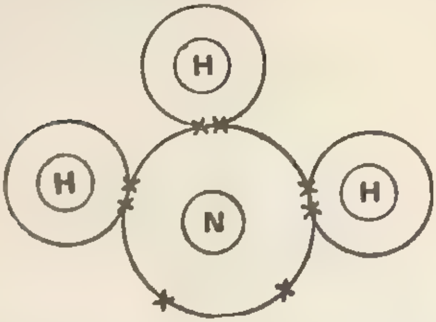
(*g*) E. (*h*) Inert gases.

28. (*a*) The electronic configurations are : (1) 2, 8, 4 ; (2) 2, 8, 7 ; (3) 2, 8, 8, 2.

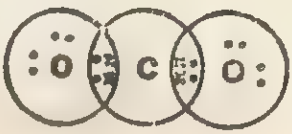
(*b*) 

(*c*) Si + 4 .Cl: ⟶ 

(*d*) Electrovalent or ionic bond. (*e*) Covalent bond.

29. (*a*) 

(*b*) Covalent bond.

30. (*a*) 4 (*b*) 6 (*c*) 

31. (a)  (b) Molecular.

32. (a) 1. Formula : LiH; Bonding : Ionic 2. Formula : LiCl; Bonding : Ionic
3. Formula : CCl_4; Bonding : Covalent 4. Formula : $CaCl_2$: Bonding : Ionic
5. Formula : HCl; Bonding : Covalent 6. Formula : PH_3; Bonding : Covalent
7. Formula : CaH_2 ; Bonding : Ionic.

(b) (1) Low melting point, insoluble in water, soluble in benzene, non-conductor of electricity. (2) High melting point, soluble in water, insoluble in benzene, conductor of electricity in molten slate. (3) Same as for (2).

33. (a) 1. Hard and brittle crystalline solids. 2. High melting points. 3. Soluble in water but insoluble in alcohol and benzene. 4. Conduct electricity in molten slate.

(b) 1. Usually liquids and gases. 2. Low melting points. 3. Soluble in alcohol and benzene but insoluble in water. 4. Do not conduct electricity.

34. (1) Loss of 2 electrons. (2) Loss of 1 electron. (3) Gain of 1 electron. (4) Gain of 2 electrons. (5) Gain of 2 electrons.

35. (1) Oxidation involves loss of electrons in a chemical reaction.
(2) Reduction involves gain of electrons in a chemical reaction.

36. In the combination of sodium and chlorine, sodium is oxidized as each sodium loses 1 electron to form Na^+ ($Na \longrightarrow Na^+ + e^-$); chlorine is reduced as each chlorine atom gains 1 electron to form Cl^- ($Cl + e^- \longrightarrow Cl^-$).

37. (1) protons, neutrons, (2) electrons, (3) protons, electrons, (4) 18, (5) 18, 22, 18. (6) an ion. (7) losing three, Al^{3+}, (8) losing one, (9) two, M, two, chlorine. (10) electrovalent, ionic. (11) double covalent bond, (12) A^{2+}, B^-, AB_2. (13) Cl^-, chlorine, Na^+, sodium. (14) lose, gain.

Chapter 9.

1. (1) Gases have no definite shape or volume. (2) Gases are highly compressible, *i.e.*, the volume of a gas can be greatly decreased by increasing the pressure upon it. (3) Gases vastly expand when the temperature is increased or the pressure upon them is reduced. (4) Gases readily diffuse and mix completely with one another. (5) Gases have much lower densities than liquids or solids. (6) Gases exert pressure equally in all directions.

2. (a) On heating, the speed of the gas molecules is increased. So, they will collide more vigorously and frequently with the walls of container. This will cause the pressure to increase. (b) When the volume is halved, the same number of gas molecules will bombard half the area of the container walls. So, the pressure will be doubled.

3. (a) The intervals of the two scales are of the same order.
(b) Kelvin temperature = Celsius temperature + 273.

4. (a) 1. The volume of a given mass of a dry gas is inversely proportional to the pressure, if the temperature remains constant. 2. At constant temperature the product of the volume and pressure of a given mass of a gas is constant.

(b) New volume = original volume $\times \dfrac{\text{Initial pressure}}{\text{Final pressure}}$

$$= 10\ m^3 \times \frac{100\ \text{atm.}}{1\ \text{atm.}} = 100\ m^3.$$

5. (a) At constant pressure, the volume of a given mass of gas is directly proportional to the absolute (kelvin) temperature.

(b) Original temperature of the gas, T_1 is 273+27°C=300°K.
Final temperature of the gas T_2 is 173+54°C=327°K

react to yield one mole of manganese (II) chloride ($MnCl_2$), two moles of water (H_2O) and one mole of chlorine (Cl_2).

7. (*a*) The molar volume of a gas means the volume occupied by one molecule of any gas at STP and is equal to 22·4 litres.

(*b*) A mole of X is equal to 24000 cm^3 of X at STP. 120 cm^3 of X at STP weigh 0·14 g. Therefore, 24000 cm^3 of X at STP weigh $\frac{0.14 \text{ g}}{120 \text{ cm}^3} \times 24000 \text{ cm}^3 = 28$ g. Hence the mass of a mole of X is 28 g.

(*c*) The weight of 1 mole of X, 28 g, gives its molecular weight as 28. Hence, the formula of X is CO.

(*d*) $CuO + CO \xrightarrow{\Delta} Cu + CO_2$.

8. (*a*) (*i*) 1 mole of $SO_2 = (32+2\times16)$ g$=64$ g. Weight of 22·4 litres (molar volume) of SO_2 is 64 g. Therefore, weight of 1·12 litres of SO_2 is $\frac{64 \text{ g}}{22.4 \text{ litres}} \times 1.12 \text{ litres} = 3.2$ g.

(*ii*) 1 mole of $H_2S = (2\times1+32)$ g$=34$ g. Therefore, weight of 4·48 litres of H_2S $= \frac{34 \text{ g}}{22.4 \text{ litres}} \times 4.48 \text{ litres} = 6.8$ g. (*iii*) 1 mole of $NH_3 = (14+3\times1)$ g$=17$ g. Therefore, weight of 5·60 litres of $NH_3 = \frac{17 \text{ g}}{22.4 \text{ litres}} \times 5.60 \text{ litres} = 4.25$ g.

(*b*) The volume of 1 mole of a gas at s.t.p. is 22·4 litres.

(*i*) 28 g of $N_2 \equiv 22.4$ litres. Therefore, 7 g of $N_2 \equiv \frac{22.4 \; l}{17 \text{ g}} \times 7 \text{ g} = 5.60$ litres.

(*ii*) 17 g of $NH_3 \equiv 22.4$ litres. Therefore, 3·4 g of $NH_3 \equiv \frac{22.4 \; l}{17 \text{ g}} \times 3.4\text{g} = 4.48$ litres.

(*iii*) 32 g of $O_2 \equiv 22.4$ litres. Therefore, 4 g of $O_2 \equiv \frac{22.4 \; l}{32 \text{ g}} \times 4\text{g} = 2.8$ litres.

9. The molecular weight of X = weight of 22·4 litres at STP of X. 5·6 litres of X at STP weighs 12 g. Therefore, 22·4 litres of X at STP weighs $= \frac{12 \text{ g}}{5.6 \; l} \times 22.4 \; l = 48$ g. Hence, molecular weight of X is 48.

10. Weight of 2·24 litres of gas at STP $= 1.7$ g. Therefore, weight of 22·4 litres of gas at STP $= \frac{1.7 \text{ g}}{2.24 \text{ l}} \times 22.4 \text{ l} = 17$ g. Hence, molecular weight of gas is 17.

11. (*a*) Vapour density of a gas is the ratio between the weights of equal volumes of that gas and hydrogen under the same conditions of temperature and pressure. It is related to molecular weight as follows : vapour density $= \frac{1}{2} \times$ molecular weight.

(*b*) (*i*) Vapour density of $X = \frac{\text{Weight of 1 litre of X at STP}}{\text{Weight of 1 litre of hydrogen at STP}} = \frac{1.35 \text{ g}}{0.09 \text{ g}} = 15.$

(*ii*) Molecular weight of X $= 2 \times$ V.D. $= 2 \times 15 = 30$.

12. (*a*) The empirical formula of a compound is a formula that shows the simplest ratio of atoms in a molecule of it ; its molecular formula is a formula that shows the actual number of atoms in a molecule of it. (*b*) CH_2O.

13. $C : H : O = \frac{37.5}{12} : \frac{12.5}{1} : \frac{50}{16} = 3.1 : 12.5 : 3.1 = 1 : 4 : 1.$

Therefore, empirical formula is CH_4O. Empirical formula weight is $12+4\times1+16=32$, which is the same as molecular weight. Hence, the molecular formula is also CH_4O.

$\therefore$ New volume of the gas $= 4{\cdot}2 \text{ litres} \times \dfrac{327°K}{300°K} = 4{\cdot}578$ litres.

6. (1) Increase, (2) Decrease, (3) Decrease, (4) Increase.

7. (*a*) The volume of a given mass of a gas varies inversely as the pressure and directly as the absolute temperature.

   (*b*) $\dfrac{P_1V_1}{T_1} = \dfrac{P_2V_2}{T_2}$, where P_1, V_1, and T_1 are the original pressure volume, and temperature of the gas, and P_2, V_2, and T_2 the pressure, volume, and temperature of the gas under new conditions. (*c*) 0°C and 760 mm pressure.

   (*d*) $P_1 = 750$ mm $V_1 = 150$ litres $T_1 = (273+27) = 300°K$
   $P_2 = 760$ mm $V_2 = ?$ $T_2 = 273°K$

   By gas equation, $\dfrac{P_1V_1}{T_1} = \dfrac{P_2V_2}{T_2}$ or $V_2 = V_1 \times \dfrac{P_1}{P_2} \times \dfrac{T_2}{T_1}$

   So, $V_2 = 150 \text{ litres} \times \dfrac{750 \text{ mm}}{760 \text{ mm}} \times \dfrac{273°K}{300°K} = 134{\cdot}7$ litres.

8. (1) directly, (2) increases, (3) decrease, (4) does not have, (5) Boyle's law, (6) Charles' law, (7) $V_1 \times T_2 = V_2 \times T_1$.

Chapter 10.

1. (*a*) Under the same conditions of temperature and pressure, equal volumes of all gases contain the same number of molecules.

   (*b*) An atom is the smallest particle of an element that can take part in a chemical reaction; however, it may or may not exist by itself. A molecule is the smallest particle of an element or compound that can exist by itself.

2. (*a*) The term 'atomicity' of an element means the number of atoms which make one molecule of that element, (*b*) A diatomic molecule is one which is made up of two atoms, for example, oxygen mol cule, O_2 and nitrogen molecule, N_2. (*c*) 1. Helium He, 2. Ozone, O_3, (3) Phosphorus, P_4. (*d*) The statement means that each molecule of oxygen is made up of two atoms of oxygen.

3. (*i*) The atomic weight of an element is the relative weight of an atom of that element compared to the weight of an atom of carbon taken as 12·000.

   (*ii*) The gram atomic weight of an element is its atomic weight expressed in grams.

   (*iii*) The molecular weight of an element or compound is the relative weight of one molecule of it compared to the weight of an atom of carbon taken as 12·000.

   (*iv*) The gram molecular weight of a substance is its molecular weight expressed in grams.

4. The statement means that on the scale on which one atom of carbon weighs 12·000, one atom of sulphur weighs 32·000. Or, one atom of sulphur weighs 32 times as much as one-twelfth the weight of one carbon atom.

5. (*a*) A mole of an element is that amount of it which contains Avagadro's number of atoms, *i.e.*, $6{\cdot}022 \times 10^{23}$ atoms.

   (*b*) Avagadro's number, *L* or N_A, is the number of elementary units contained in a mole of substance. Its value is $6{\cdot}022 \times 10^{23}$.

6. (*a*) A mole of atoms of oxygen stands for (1) $6{\cdot}022 \times 10^{23}$ atoms of oxygen and (2) one gram atomic weight, *i.e.*, 16 grams of oxygen.

   (*b*) $6{\cdot}022 \times 10^{23}$ Mg^{2+} ions and $2 \times 6{\cdot}22 \times 10^{23}$ Cl^- ions.

   (*c*) Weight of $6{\cdot}0 \times 10^{23}$ atoms of magnesium is 24 grams. Therefore, weight of one atom of magnesium $= 24 \text{ grams}/6{\cdot}0 \times 10^{-23} = 4 \times 10^{-23}$ gram.

   (*d*) Gram molecular weight of $CaCO_3 = (40+12+3\times16)g = 100$ g. That is, 1 mole of $CaCO_3$ weighs 100 g. Therefore, 1·42 moles of $CaCO_3$ weigh 142 g.

   (*e*) One mole of manganese dioxide (MnO_2) and four moles of hydrogen chloride (HCl)

14. (*i*) $\frac{18\text{ g}}{24\text{ g}}\times 1$ g-atom=0·65 g-atom of magnesium. (*ii*) $\frac{7\text{ g}}{14\text{ g}}\times 1$ g-atom=0·5 g-atom of nitrogen. (*iii*) 0·75 : 0·50=3 : 2. (*iv*) Mg_3N_2.

15. (*i*) 2 litres. (*ii*) 1 litre. [According to the equation, 2 molecules of carbon monoxide combine with one molecule of oxygen to form 2 molecules of carbon dioxide. By Avogadro's law, molecules of gases correspond to volumes. Hence, 2 volumes of carbon monoxide combine with 1 volume of oxygen to form 2 volumes of carbon dioxide. Or, 2 litres of carbon monoxide combine with 1 litre of oxygen to form 2 litres of carbon dioxide].

16. (*i*) volumes, (*ii*) 44·8 litres, (*iii*) $2\times 6{\cdot}022\times 10^{23}$, (*iv*) X_2Y_4, (*v*) 9, (*vi*) 2, 1, (*vii*) 4, 6, (*viii*) M_2O_3, MCl_3.

Chapter 11.

1. (*a*) 4 moles, (*b*) 2 moles, (*c*) 44·8 litres.

2. (*a*) 2 molecules of zinc sulphide react with 3 molecules of oxygen to produce 2 molecules of zinc oxide and 2 molecules of sulphur dioxide.

(*b*) 2 moles of zinc sulphide react with 3 moles of oxygen to give 2 moles of zinc oxide and 2 moles of sulphur dioxide.

(*c*) 2(65+32)=194 g of zinc sulphide react with (3×2×16)=96 g of oxygen to give 2(65+16)=162 g of zinc oxide and 2(32+2×16)=128 g of sulphur dioxide.

(*d*) Volumes of oxygen used up and sulphur dioxide produced are in the ratio 3 : 2.

(*e*) 22·4 litres. (*f*) 194 g of zinc sulphide produces 44·8 litres of sulphur dioxide at s.t.p. Hence, required weight of zinc sulphide is $\frac{194\text{ g}}{44{\cdot}8\text{ litres}}\times 11{\cdot}2$ litres=48 5 g.

(*g*) 194 g of zinc sulphide gives 162 g of zinc oxide. Hence, weight of zinc oxide produced from 38·8 kg of zinc sulphide is $\frac{162\text{ g}}{194\text{ g}}\times 38{\cdot}8$ kg=32·4 kg.

3. (*a*) $2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$,

(*b*) 2 moles of lead (II) nitrate yield 4 molar volumes of NO_2 and 1 molar volume of O_2 (molar volume=22·4 litres at s t p.). Hence, 0·1 mole of crystals will yield 0·2 molar volume or 0·2×22·4=**4·48 litres of NO_2** and 0·05 molar volume or 0·05×22·4=**1·12 litres of O_2.**

4. According to the equation, 3 volumes of hydrogen are converted into 2 volumes of ammonia. Hence, volume of ammonia from 12 litres of hydrogen is $\frac{2\text{ vol}}{3\text{ vol}}\times 12$ litres =8 litres.

5. According to the equation, (40+12+3×16)=100 g of calcium carbonate yield (40+2×35·5)=111 g of calcium chloride and 22·4 litres of carbon dioxide at s.t p.

(*a*) Hence, weight of calcium chloride from 20 g of calcium carbonate is $\frac{111\text{ g}}{100\text{ g}}\times 20$ g =22·2 g, and (*b*) volume at s.t.p. of carbon dioxide is $\frac{22{\cdot}4\text{ litres}}{100\text{ g}}\times 20$ g=**4·48 litres.**

6. Molecular weight of butane is 4×12+10×1=50 g. Hence, 174 g of butane=$\frac{1\text{ mole}}{58\text{ g}}\times 174$ g =3 moles. According to the equation, 2 moles of butane need 13 moles of oxygen and produce 8 molar volumes, *i.e.*, 8×22·4 litres=179·2 litres of carbon dioxide at s.t.p. Hence, 174 g or 3 moles of butane—

(*i*) will require $\frac{13\text{ moles}}{2\text{ moles}}\times 3$ moles=19·5 moles of oxygen for complete combustion, and

(*ii*) will produce $\frac{179.2 \text{ litres}}{2 \text{ moles}} \times 3$ moles $= 268.8$ litres of carbon dioxide at s.t.p.

7. (*a*) $ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$.

(*b*) According to the equation, $(65+12+3\times16)=125$ g of zinc carbonate yield $(65+16) = 81$ g of zinc oxide (solid residue) and 22·4 litres of carbon dioxide at s.t.p.

Hence, 25 g of zinc carbonate will yield solid residue $= \frac{81 \text{ g}}{125 \text{ g}} \times 25 \text{ g} = \mathbf{16.2 \text{ g}}$, and carbon dioxide $= \frac{22.4 \text{ litres}}{125 \text{ g}} \times 25 \text{ g} = \mathbf{4.48 \text{ litres}}$.

8. Weight of carbon in the candle $= \frac{80}{100} \times 300 \text{ g} = 240$ g.

Weight of hydrogen in the candle $= \frac{20}{100} \times 300 \text{ g} = 50$ g.

On complete combustion, carbon and hydrogen yield carbon dioxide and water respectively according to the equations :

$$\underset{12 \text{ g}}{C} + O_2 \longrightarrow \underset{(12+2\times16)=44 \text{ g}}{CO_2} \qquad \text{and} \qquad \underset{2\times2\times1=4 \nu}{2H_2} + O_2 \longrightarrow \underset{2(2\times1+16)=36 \text{ g}}{2H_2O}$$

12 g carbon yields 44 g of carbon dioxide. Therefore, 243 g of carbon will yield

$$\frac{44 \text{ g}}{12 \text{ g}} \times 240 = \mathbf{880 \text{ g of carbon dioxide.}}$$

4 g hydrogen yields 36 g of water. Therefore, 60 g of hydrogen will yield

$$\frac{36 \text{ g}}{4 \text{ g}} \times 60 \text{ g} = \mathbf{540 \text{ g of water.}}$$

9. The relevant equation is :

$$\underset{\substack{2\times22.4 \text{ dm}^3\\=44.8 \text{ dm}^3}}{2CO} + \underset{22.4 \text{ dm}^3}{O_2} \longrightarrow \underset{\substack{2(12+2\times16)\\=88 \text{ g}}}{2CO_2}$$

Obviously, 1 dm^3 of oxygen will react with 2 dm^3 of carbon monoxide to give $\frac{88 \text{ g}}{22.4} = 3.93$ g of carbon dioxide.

10. The relevant equation is :

$$\underset{\substack{2(2\times1+2\times16)\\=68 \text{ g}}}{2H_2O_2} \longrightarrow 2H_2O + \underset{\substack{2\times16=32 \text{ g}\\ \text{Or, } 22.4 \text{ dm}^3}}{O_2}$$

68 g of hydrogen peroxide yields 32 g or 22·4 dm^3 of oxygen at s.t.p.

$\therefore$ 34 g of hydrogen peroxide yields $\frac{32 \text{ g}}{68 \text{ g}} \times 34 \text{ g} = \mathbf{16 \text{ g}}$ or $\frac{22.4 \text{ dm}^3}{68 \text{ g}} \times 34 \text{ g} = \mathbf{11.2 \text{ dm}^3}$ **of oxygen.**

11. (*i*) $8(1+14+3\times16)$, *i e.*, 8×63 g of nitric acid (HNO_3) $\equiv 3\times64$ g of copper.

$\therefore$ 63 g of nitric acid $\equiv \frac{3\times64 \text{ g}}{8\times63 \text{ g}} \times 63 \text{ g} = 24$ g of copper

(*ii*) 3×64 g of copper $\equiv 2\times22.4$ litres of NO at s.t.p.

$\therefore$ 24 g of copper $\frac{2\times22.4 \text{ litres}}{3\times64 \text{ g}} \times 24\text{g} = 5.6$ litres of NO at s.t.p.

12. The equation for the reaction is : $Mg + CuSO_4 \longrightarrow MgSO_4 + Cu$
24 g of magnesium precipitates 64 g of copper.

$\therefore$ 1·2 g of magnesium will precipitate $\frac{64 \text{ g}}{24 \text{ g}} \times 1.2 \text{ g} = 3.2$ g of copper.

Chapter 12.

1. (1) An electrolyte is a compound which in molten state or in solution conducts electricity, and is composed as a result of it.

   (2) Anode is the electrode connected to the positive pole of battery and by which electrons leave the electrolyte.

   (3) Cathode is the electrode connected to the negative pole of battery and by which electrons enter the electrolyte.

   (4) Electrolysis is the decomposition of a substance when a direct current of electricity is passed through it.

2. (1) A solution of cane sugar contains uncharged molecules which do not move under the influence of electric current. A solution of common salt contains Na^+ and Cl^- ions. These ions move towards and reach the oppositely charged electrode when electric current is passed. Cl^- ions give up electrons at the anode (to become first chlorine atoms and then chlorine molecules). These electrons are conducted up to cathode through the battery where Na^+ ions pick them up to become Na atoms. The movement of electrons from the anode, through the battery, to the cathode is the conduction of electric current through the solution.

   (2) Copper conducts electric current by a flow of electrons and not by a flow of ions. Unlike an electrolyte, copper does not undergo chemical change when electricity flows through it.

3. Electrolytic dissociation is the breaking up of an *electrovalent* compound into its ions when it is melted or dissolved in water. Ionization is the process by which a *covalent* compound changes into ions in solution.

4. (*a*) In sodium chloride crystal Na^+ and Cl^- ions are rigidly held in their positions by electrostatic attraction, and cannot move. In aqueous solution or molten state these ions become free to move about as the forces of attraction between them are overcome. (*b*) When fused sodium chloride is electrolyzed, sodium metal is deposited at the cathode and chlorine is evolved at the anode. Electric current is conducted by movement of Cl^- ions to the anode where they give up electrons, and of Na^+ ions to the cathode where they pick up the electrons given up by Cl^- ions and conducted through the battery to the cathode.

   (*c*) $Cl^- \longrightarrow Cl + e^-$; (*i*) $2Cl \longrightarrow Cl_2$; (*ii*) $Na^+ + e^- \longrightarrow Na$.

5. Hydrogen chloride is a covalent compound consisting of molecules. Hence, it does not conduct electricity in the liquid state. When it is dissolved in water, the electrons shared between hydrogen and chlorine atoms go completely with the chlorine atom. Thus, H^+ and Cl^- ions are formed and the solution conducts electricity :

$$H : \underset{\cdot\cdot}{\overset{\cdot\cdot}{Cl}} : \xrightarrow{H_2O} H^+ + [: \underset{\cdot\cdot}{\overset{\cdot\cdot}{Cl}} :]^-$$

6. Acids, bases and salts are three classes of electrolyte.

   (1) $H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{2-}$; (2) $NaOH \rightleftharpoons Na^+ + OH^-$; (3) $NaCl \rightleftharpoons Na^+ + Cl^-$.

7. (1) (*i*) Strong electrolyte, (*ii*) Weak electrolyte. (*iii*) Non-electrolyte.

   (2) (*i*) Solution of sulphuric acid, solution of sodium hydroxide.
   (*ii*) Acetic acid, Ammonium hydroxide.
   (*iii*) Solution of cane sugar, Ethyl alcohol.

8. (1) In the solid lead bromide the ions Pb^{2+} and Br^- are not free to move. When lead bromide melts, these ions become free to move about ($PbBr_2 \longrightarrow Pb^{2+} + 2Br^-$). These ions conduct electricity through the electrolyte.

   (2) (*i*) Bromine vapour, (*ii*) Lead metal.

   (3) (*i*) $Br^- \longrightarrow Br + e^-$; $2Br \longrightarrow Br_2\uparrow$, (*ii*) $Pb^{2+} + 2e^- \longrightarrow Pb$.

   (4) (*i*) and (*iv*).

9. (*a*) As the current flows, colourless gases begin to collect in the graduated tubes by downward displacement of water. The volume of the gas collecting over the electrode connected to the negative pole of the battery (*i.e.*, the cathode) at any instant is twice as much as that of the gas collecting over at the other electrode. When tested, the gas of double the volume was found to be hydrogen, and the other gas oxygen.

(*b*) Water containing a little sulphuric acid contains H^+, OH^-, and SO_4^{2-} ion from the ionization of water and the acid ($H_2O \rightleftharpoons H^+ + OH^-$; $H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{2-}$). Of the OH^- and SO_4^{2-} anions, the former are preferentially discharged by loss of electrons at the anode forming water and oxygen ($4OH^- \longrightarrow 2H_2O + O_2 + 4e^-$). The H^+ ions pick up electrons at the cathode and are discharged as the hydrogen gas ($4H^+ + 4e^- \longrightarrow 2H_2$). It is seen from the equations for electrode reactions that as many electrons are used up in the formation of two hydrogen molecules as are given up in the formation of one oxygen molecule. This explains, why the volume of hydrogen is twice that of oxygen.

10. (*a*) (*i*) Oxygen ; $4OH^- \longrightarrow 2H_2O + O_2\uparrow + 4e^-$, (*ii*) Copper ; $Cu^{2+} + 2e^- \longrightarrow Cu$.

(*b*) (*i*) Cu^{2+} ions ; $Cu \longrightarrow Cu^{2+} + 2e^-$, (*ii*) Copper ; $Cu^{2+} + 2e^- \longrightarrow Cu$.

(*c*) This electrolysis is made use of for the electro-refining of copper. The metal obtained is 99·99 per cent pure.

11. (*a*) A greenish-yellow gas (chlorine) is evolved at the carbon anode. A film of bright reddish-brown copper metal is deposited at the cathode.

12. 1 At cathode, Product-Hydrogen ; Equation : $2H^+ + 2e^- \longrightarrow H_2$
At anode, Product-Oxygen ; Equation : $4OH^- \longrightarrow 2H_2O + O_2 + 4e^-$
2. At cathode, Product-Copper ; Equation : $Cu^{2+} + 2e^- \longrightarrow Cu$
At anode, Product-Oxygen ; Equation : $4OH^- \longrightarrow 2H_2O + O_2 + 4e^-$
3. At cathode, Product-Copper ; Equation : $Cu^{2+} + 2e^- \longrightarrow Cu$
At anode, Product-Cu^{2+} ; Equation : $Cu \longrightarrow Cu^{2+} + 2e^-$

13. (*a*) Aqueous copper (II) sulphate contains Cu^{2+} and SO_4^{2-} ions from the dissociation of $CuSO_4$, and H^+ and OH^- from the ionization of water. Of the cations Cu^{2+} and H^+ in solution, the Cu^{2+} ions are preferentially discharged as copper atoms at the cathode ($Cu^{2+} + 2e^- \longrightarrow Cu$). However, neither of the anions SO_4^{2-} and OH^- is discharged at the anode ; instead, the copper atoms in the anode lose two electrons each to form Cu^{2+} ions ($Cu \longrightarrow Cu^{2} + 2e^-$) which go into the solution.

(*b*) The net result of these reactions is that the anode loses copper as Cu^{2+} ions to the electrolyte from which an equivalent amount of Cu^{2+} ions are discharged at the cathode as copper metal.

14. (*a*) (*i*) $2O^{2-} \longrightarrow O_2 + 4e^-$, (*ii*) $Ag^+ + e^- \longrightarrow Ag$
(*iii*) $2Cl^- \longrightarrow Cl_2 + 2e^-$ (*iv*) $2H^+ + 2e^- \longrightarrow H_2$

(*b*) (*i*) $2O^{2-} \longrightarrow O_2 + 4e^-$ and $2Cl^- \longrightarrow Cl_2 + 2e^-$
(*ii*) $Ag^+ + e^- \longrightarrow Ag$ and $2H^+ + 2e^- \longrightarrow H_2$

(*c*) Electroplating, *i.e.*, coating one metal with another, and refining of copper.

(*d*) Sodium, calcium, magnesium, and aluminium.

15. (*a*) Electroplating is an electrolytic process by which one metal is coated with another either to make it attractive or to protect it against corrosion.

(*b*) Electrolyte : A solution containing Ag^+ ions. Anode : A bar of silver.
Cathode : Article to be silver-plated.

(*c*) (*i*) $Ag \longrightarrow Ag^+ + e^-$, (*ii*) $Ag^+ + e^- \longrightarrow Ag$.

(*d*) The silver atoms in the silver anode lose one electron each to form Ag^+ ions. These ions pass into the electrolyte. The Ag^+ ions in the electrolyte gain one electron each to form silver atoms which are deposited on the cathode.

16. (*a*) (*i*) $Cl^- \longrightarrow Cl + e^-$; $Cl + Cl \longrightarrow Cl_2\uparrow$ (*ii*) $Ca^{2+} + 2e^- \longrightarrow Ca$

(*b*) (*i*) $2O^{2-} \longrightarrow O_2 + 4e^-$ (*ii*) $Al^{3+} + 3e^- \longrightarrow Al$

17. (*a*) Aqueous copper (II) sulphate. (*b*) Slab of impure copper to be refined. (*c*) Thin sheet of pure copper. (*d*) Copper atoms from the anode lose 2 electrons each to form Cu^{2+} ions. (*e*) Cu^{2+} ions from the electrolyte are discharged as copper atoms. (*f*) The electrolyte remains unchanged (*g*) Cathode. (*h*) Anode.

18. The electrolyte remains unchanged as it receives as many Cu^{2+} ion by the anode reaction ($Cu \longrightarrow Cu^{2+} + 2e^-$) as it transfers to the cathode to be discharged as copper atoms ($Cu^{2+} + 2e^- \longrightarrow Cu$).

19. (*i*) $H^+ + OH^- \longrightarrow H_2O$ (*ii*) $Zn + 2H^+ \longrightarrow Zn^{2+} + H_2$
(*iii*) $Ag^+ + Cl^- \longrightarrow AgCl$ (*iv*) $CO_3^{2-} + 2H^+ \longrightarrow H_2O + CO_2$
(*v*) $Fe + Cu^{2+} \longrightarrow Fe^{2+} + Cu$.

20. (*a*) (*i*) an electrolyte, (*ii*) it does not contain ions; it contains H^+ and Cl^- ions. (*iii*) gaining two electrons, (*iv*) anode, (*v*) electrolysis, (*vi*) anode, (*vii*) the Na^+ and Cl^- ions are held in a rigid crystal lattice and cannot move to the electrodes. (*viii*) cathode.

(*b*) (*i*) Sugar, (*ii*) Solid, (*iii*) non-electrolyte, (*iv*) ionizes, (*v*) reversible, (*vi*) strong, (*vii*) OH^-, (*viii*) oxidation, anode, (*ix*) reduction, (*x*) electronegative.

Chapter 13.

1. (*a*) Allotropy is the phenomenon of an element existing in two or more forms in the same physical state.
(*b*) Allotropy results from different arrangements of atoms in the molecules.

2. (1) Diamond ; (*i*) As gems, (*ii*) As a hard material in drills, dies, etc.
(2) Graphite ; (*i*) In making electrodes, (*ii*) In nuclear reactors.

3.

	Diamond	*Graphite*
(*i*)	Hard	Soft
(*ii*)	Non-conductor of electricity	Conductor of electricity
(*iii*)	Three dimensional cystal structure	Two-dimensional, hexagonal layered structure

4. By burning separate by equal weights of different allotropes in oxygen and absorbing the carbon dioxide formed in weighed bulbs containing potash (KOH) solution. Each allotrope produces the same quantity of carbon dioxide.

5. (*a*) Destructive distillation is the process of heating an organic material in the absence of air and condensing the volatile products.
(*b*) (1) A combustible gas, (2) Wood tar, (3) Pyroligneous acid. (4) Wood char-coal.

6. (*a*) Because charcoal is porous and it adsorbs large quantities of air on its surface.
(*b*) Adsorption is the accumulation of the molecules of a substance on the surface of the adsorbing agent.
(*c*) Activated charcoal is charcoal so treated as to remove the matter clogging its pores. So, it can adsorb large quantities of gases.

7. (*i*) $Fe_2O_3 + 3C \longrightarrow 3Fe + 3CO$, (*ii*) $C + CO_2 \longrightarrow 2CO$,
(*iii*) $C + H_2O \longrightarrow CO + H_2$, (*iv*) $C + 2H_2SO_4 \longrightarrow 2H_2O + 2SO_2 + CO_2$,
(*v*) $C + 4HNO_3 \longrightarrow 2H_2O + 4NO_2 + CO_2$.

8. (1) As an adsorbent of gases in gas masks and for removing odoriferous gases from petroleum products.
(2) For decolorizing petroleum products and alcohol.
(3) As a constituent of gun powder.

9. (*a*) Bone black is the residue obtained when bones are heated in the absence of air.
(*b*) Bone black consists of about 10 per cent carbon deposited on a porous framework of calcium phosphate.
(*c*) For decolorizing sugar.

10. (1) allotropy, (2) diamond, (3) graphite, (4) refractive index, (5) carbon monoxide,

Chapter 14.

1. In the lower part of the fire carbon burns forming carbon dioxide ($C + O_2 \longrightarrow CO_2$). The carbon dioxide rises up through the glowing coal, and is reduced to carbon monoxide ($CO_2 + C \longrightarrow 2CO$). The carbon monoxide burns in air producing blue flames ($2CO + O_2 \longrightarrow 2CO_2$).

2. (*a*) $CO_2 + C \xrightarrow{\Delta} 2CO$. (*b*) (*i*) By heating oxalic acid ($H_2C_2O_4$) with concentrated sulphuric acid. (*ii*) $H_2C_2O_4 + H_2SO_4 \xrightarrow{\Delta} [H_2SO_4 + H_2O] + CO_2\uparrow + CO\uparrow$. (*iii*) Dehydrating action (*i.e.*, affinity for water), (*iv*) By passing the mixture through a solution of potassium hydroxide in which carbon dioxide dissolves ($2KOH + CO_2 \longrightarrow K_2CO_3 + H_2O$). Carbon monoxide passes over, and is collected over water. (*c*) Because carbon monoxide is highly poisonous.

3. Carbon monoxide burns in air to produce carbon monoxide ($2CO + O_2 \longrightarrow 2CO_2$.).

4. (*a*) The liquid is a solution of copper (I) chloride in ammonia.
   (*b*) Carbon monoxide dissolves in this solution by forming an addition product.

$$CuCl + 2H_2O + CO \longrightarrow CuCl.CO.2H_2O$$

5. (*i*) $CuO + CO \longrightarrow Cu + CO_2$, (*ii*) $PbO + CO \longrightarrow Pb + CO_2$,
   (*iii*) $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$.

6. (*i*) It is made when carbon monoxide and chlorine are exposed to sunlight in the presence of charcoal catalyst : $CO + Cl_2 \longrightarrow COCl_2$.
   (*ii*) It is made by heating solid sodium hydroxide with carbon monoxide under 6—10 atmospheres to 200°C : $CO + NaOH \longrightarrow H.COONa$.
   (*iii*) It is made by passing a mixture of carbon monoxide with twice its volume of hydrogen over a catalyst of zinc and chromium oxides at 400°C : $CO + 2H_2 \longrightarrow CH_3OH$.

7. (*a*) Calcium oxide. (*b*) Reverse reaction is prevented by maintaining a good drought of air passing up the lime kiln. The drought of air continually sweeps out the carbon dioxide formed.
   (*c*) The lump of quicklime cracks, swells, and crumbles to a dry white powder of calcium hydroxide. So much heat is generated that the water turns into steam.

$$CaO + H_2O \rightleftharpoons Ca(OH)_2 + \textit{heat}.$$

8.

	Chalk	*Quicklime*	*Slaked lime*
Chemical Name Formula	Calcium Carbonate $CaCO_3$	Calcium Oxide CaO	Calcium Hydroxide $Ca(OH)_2$
Action of heat	Decomposes to give calcium oxide and carbon dioxide	Does not melt or change ; emits intense white light.	Loses water to yield calcium oxide.
Action of water	Insoluble; no action.	Combines with water to give calcium hydroxide.	Sparingly dissolves and forms a milky suspension.

9. (*a*) Mortar is a paste-like mixture of slaked lime (1 part), sand (3—4 parts) and water.
   (*b*) It is used in the construction of buildings for sticking bricks together and for plastering the walls.
   (*c*) The mortar hardens as the water evaporates and the carbon dioxide of the air converts the calcium hydroxide in slaked lime to calcium carbonate.

10. Finely powdered slaked lime is spread on soils containing too much of acids produced by the decay of animal and vegetable matter. The slaked lime neutralizes acids and thereby improves the fertility of the soil. Furthermore, slaked lime causes tiny clay particles to agglomerate into bigger particles. As a result the soil becomes porous and better workable.

11. (*a*) Lime water.

(*b*) For the detection of carbon dioxide which causes it to turn milky.

(*c*) A white crust of insoluble calcium carbonate is formed on its surface as a result of chemical action with the carbon dioxide of air : $Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$.

12. (*a*) It is made from slaked lime by the action of chlorine gas :

$$Ca(OH)_2 + Cl_2 \longrightarrow \underset{\text{bleaching powder}}{CaOCl_2} + H_2O$$

(*b*) It is made by boiling a calculated quantity of slaked lime with solution of sodium carbonate : $Na_2CO_3 + Ca(OH)_2 \longrightarrow CaCO_3\downarrow + 2NaOH$.

13. (*a*) (*i*) $NaHCO_3$, (*ii*) $Ca(HCO_3)_2$. (*b*) Sodium hydrogen carbonate and potassium hydrogen carbonate. (*c*) The hydrogen carbonates lose water and carbon dioxide, and are converted into corresponding carbonates.

(*d*) (*i*) $2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2\uparrow$

(*ii*) $Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 + H_2O + CO_2\uparrow$

14. (1) By heating : $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

(1) By the action of dilute hydrochloric acid : $CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2\uparrow$.

15. (*a*) By the action of dilute hydrochloric acid on calcium carbonate in the form of marble or chalk : $CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$.

(*b*) Because carbon dioxide is fairly soluble in water.

(*c*) By upward displacement of air, because it is heavier than air.

(*d*) By burning magnesium in it ; magnesium combines with the oxygen of carbon dioxide and sets free carbon : $2Mg + CO_2 \longrightarrow 2MgO + C$.

(*e*) (1) In making effervescent beverages. (2) In the manufacture of washing soda, $Na_2CO_3.10\,H_2O$; baking soda, $NaHCO_3$; and white lead, $Pb(OH)_2.PbCO_3$.

16. (*a*) Magnesium wire continues to burn with dazzling light and is converted into white magnesium oxide. Black specks of carbon are deposited on the walls of the jar.

$$2Mg + CO_2 \longrightarrow 2MgO + C.$$

(*b*) Carbon dioxide dissolves in water which turns 'port wine' in colour. This is due to the formation of carbonic acid : $H_2CO_3.H_2O + CO_2 \longrightarrow H_2CO_3$.

(*c*) First, the lime water turns milky as insoluble calcium carbonate is formed :

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3\downarrow + H_2O.$$

On passing more carbon dioxide the milkiness disappears as calcium carbonate changes into soluble calcium hydrogen carbonate :

$$CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$$

On boiling the liquid, it again turns milky as calcium hydrogen carbonate is changed into calcium carbonate : $Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 + H_2O\downarrow + CO_2$.

17. (*a*) Dry ice is solid carbon dioxide. This name arises from the fact that it vaporizes without becoming liquid.

(*b*) The function of sodium hydrogen carbonate is to release carbon dioxide by the action of the acidic substance present in baking powder when added to the dough.

18. (*a*) A soda-acid fire extinguisher is a metal cylinder nearly three-fourth full of sodium hydrogen carbonate solution and having a small loosely stoppered glass bottle containing sulphuric acid supported in a recepticle near the top.

(*b*) When the extiguisher is turned upside down, the acid mixes with the sodium hydrogen carbonate solution to produce carbon dioxide under high pressure. The gas pressure forces out a stream of solution saturated with carbon dioxide which extinguishes the fire. (*c*) The reason is that the solution ejected from the extinguisher is an electrolyte and it may start another fire by causing a short circuit in any electrical equipment in or near the fire. (*d*) This is because the liquid from the extinguisher being denser than the blazing oil sinks below it without any effect on the fire.

19. (*a*) A foam type fire extinguisher uses : (1) a water solution of sodium bicarbonate and saponin or licorice extract, and (2) a water solution of aluminium sulphate in a separate bottle.

(*b*) Sodium bicarbonate is the source of carbon dioxide. Aluminium sulphate produces sulphuric acid by hydrolysis which releases carbon dioxide from sodium bicarbonate. Aluminium hydroxide, also produced by the hydrolysis of aluminium sulphate, is blown into a foam which is stabilized by saponin or licorice extract.

20. (1) Carbon dioxide dissolved in natural waters dissolves out the carbonates of calcium and magnesium from their minerals by converting them into corresponding hydrogen carbonates, *e.g.*, $CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$. This changes the topography of chalk hills which are slowly dissolved out.

(2) Carbon dioxide dissolved in large water bodies (*e.g.*, oceans) is in equilibrium with the carbon dioxide in air. When the carbon dioxide content in air rises, the excess amount dissolves in ocean waters. When there is a temporary shortage of carbon dioxide in air, the dissolved gas is released to make up the shortage.

21. (*a*) (*i*) Respiration by animals ; respired air contains 3 per cent of carbon dioxide.

(*ii*) Burning of fuels, such as wood, coal, coke, etc.

(*b*) (*i*) Dissolution of carbon dioxide in natural waters, mainly oceans.

(*ii*) Formation of carbohydrates by green plants using carbon dioxide of air and water. This process, called photosynthesis, occurs under sunlight.

22.

Carbon monoxide	*Carbon dioxide*
1. Burns in air with a blue flame producing carbon dioxide.	Does not burn in air.
2. Neutral oxide ; does not dissolve in water.	Acidic oxide ; dissolves in water forming carbonic acid, H_2CO_3.
3. Does not react with lime water.	Turns lime water milky producing calcium carbonate.

23. (*a*) By burning carbon dioxide in air : $2CO + O_2 \longrightarrow 2CO_2$.

(*b*) By passing carbon dioxide through a deep bed of glowing charcoal :

$$CO_2 + C \longrightarrow 2CO_2.$$

24. (1) By forcing the mixture under pressure through water in which carbon dioxide dissolves ; carbon monoxide passes out. On heating the solution, carbon dioxide is released.

(2) By passing the mixture through sodium carbonate solution. Carbon dioxide dissolves forming sodium hydrogen carbonate ; carbon monoxide passes out. Sodium hydrogen carbonate is crystallized out from the solution and heated to obtain carbon dioxide.

(3) By passing the mixture through a solution of copper (I) chloride (CuCl) in hydrochloric acid. Carbon monoxide dissolves forming $CuCl.CO.2H_2O$; carbon dioxide passes out. On heating the solution carbon monoxide is obtained.

25. (1) dehydration, (2) a neutral, (3) sodium, (4) milk of lime, (5) calcium carbonate, (6) an acidic, (7) Carbon dioxide, (8) a reducing agent.

Chapter 15.

1. The combination of carbon dioxide and water to form carbonic acid is a reversible reaction : $H_2O + CO_2 \rightleftharpoons H_2CO_3$. When the solution is heated, the carbonic acid decomposes into water and carbon dioxide.

2. (*a*) Two.

   (*b*) (*i*) Normal salts or carbonates, *e.g.*, sodium carbonate, Na_2CO_3, and calcium carbonate, $CaCO_3$. (*ii*) Acid salts or hydrogen carbonates, *e.g.*, sodium hydrogen carbonate, $NaHCO_3$, and calcium hydrogen carbonate, $Ca(HCO_3)_2$.

   (*c*) (*i*) The milkiness in the suspension gradually disappears and a clear solution is formed.

   (*ii*) Calcium carbonate is insoluble in water and forms a milky suspension. When carbon dioxide is passed through the suspension, calcium carbonate reacts with water and carbon dioxide forming soluble calcium hydrogen carbonate.

   (*iii*) $CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$.

   (*d*) (*i*) The clear liquid again becomes milky as calcium hydrogen carbonate changes into calcium carbonate.

   (*ii*) No lather is formed ; instead a sticky scum forms.

   (*iii*) A white precipitate of calcium carbonate is formed.

   (*e*) (*i*) $Ca(HCO_3)_2 \xrightarrow{\text{boil}} CaCO_3\downarrow + H_2O + CO_2\uparrow$

   (*ii*) $2NaSt + Ca(HCO_3)_2 \longrightarrow 2NaHCO_3 + CaSt_2$.

   (*iii*) $Ca(HCO_3)_2 + Na_2CO_3 \longrightarrow CaCO_3\downarrow + 2NaHCO_3$.

3. (*a*) Sodium carbonate, potassium carbonate, and ammonium carbonate.

   (*b*) By adding sodium carbonate to the solution of a soluble salt of the metal, *e.g.*, calcium chloride, copper sulphate, etc. $CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3\downarrow + 2NaCl$;
   $CuSO_4 + Na_2CO_3 \longrightarrow CuCO_3\downarrow + Na_2SO_4$.

4. Hard water contains dissolved salts of calcium and magnesium (*e.g.*, chlorides, sulphates, and bicarbonates). When soap is rubbed with hard water, the sodium stearate in the soap reacts with dissolved calcium and magnesium salts to form calcium and magnesium stearates by double decomposition. These stearates are insoluble and form a scum instead of lather.

$$\underset{\text{(soluble soap)}}{\text{Sodium stearate}} + \underset{\text{(in hard water)}}{\text{Calcium salt}} \longrightarrow \underset{\text{(soluble)}}{\text{Sodium salt}} + \underset{\text{(scum)}}{\text{Calcium stearate}}$$

5. (*a*) Hard water contains dissolved minerals of calcium and magnesium. When hard water is boiled, the calcium bicarbonate present in it changes to insoluble carbonate which deposits on the inner walls of the boiler as a white crust.

   (*b*) Boiler scale reduces flow of water through pipes. Since boiler scale is a poor conductor of heat, its formation results in larger consumption of fuel. Also, because of overheating, the boiler deteriorates rapidly. The boiler scale develops cracks on heating through which water reaches the red-hot surface of the boiler and is rapidly converted into steam under high pressure. This may result in explosion.

6. (*a*) Calcium hydrogen carbonate and magnesium hydrogen carbonate.

(*b*) Calcium chloride, magnesium chloride, calcium sulphate, and magnesium sulphate.

(*c*) Temporary hard water becomes soft on boiling as the hydrogen carbonates of calcium and magnesium causing temporary hardness change into insoluble carbonates. Permanent hardness is not removed on boiling as the chlorides of calcium and magnesium causing hardness do not change on boiling.

(*d*) (*i*) Temporary hard water may be prepared by passing carbon dioxide until the milkiness caused initially is cleared. The solution now contains calcium hydrogen carbonate which causes temporary hardness.

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3\ ;\ CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$$

(*ii*) Permanent hard water may be prepared by adding hydrochloric acid which will convert calcium hydroxide into calcium chloride.

$$Ca(OH)_2 + 2HCl \longrightarrow CaCl_2 + 2H_2O.$$

7. A hard water is called 'temporary' if its hardness can be removed merely by boiling. This happens when the hardness is caused by the presence of the hydrogen carbonates of calcium and magnesium. On boiling, these hydrogen carbonates are converted into the corresponding carbonates which are insoluble. For example,

$$Ca\,(HCO_3)_2 \xrightarrow{\Delta} CaCO_3\downarrow + H_2O + CO_2\uparrow.$$

A hard water is called 'permanent' if its hardness is not removed by boiling. Permanent hardness is caused by the chlorides and sulphates of calcium and magnesium which do not change on heating.

8. (1) By boiling, whereby soluble hydrogen carbonates of calcium and magnesium are converted into insoluble carbonates : $Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3\downarrow + H_2O + CO_2\uparrow$.

(2) By adding calculated quantity of slaked lime which converts the soluble hydrogen carbonates of calcium and magnesium into insoluble carbonates.

$$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3\downarrow + 2H_2O.$$

9. (1) By adding sodium carbonate (washing soda) which removes calcium chloride as insoluble calcium carbonate : $CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3\downarrow + 2NaCl$.

(2) By passing through permutit or zeolite, which may be represented as Na_2Z :

$$CaCl_2 + Na_2Z \longrightarrow CaZ + 2NaCl$$

10. (*a*) Permutit is a synthetic zeolite made by fusing together quartz (SiO_2), China clay (Al_2O_3), and sodium carbonate (Na_2CO_3). Chemically, it is sodium aluminium silicate.

(*b*) Permutit exchanges its sodium with the calcium and magnesium of the salts which cause hardness in water. Thus, the hard water is freed from calcium and magnesium salts, and its hardness removed.

(*c*) Exhausted permutit is reactivated by allowing it to stand in contact with a saturated solution of sodium chloride.

11. (1) Sodium carbonate, (2) sodium hydrogen carbonate, (3) magnesium hydrogen carbonate, (4) sodium stearate, (5) caustic soda.

Chapter 16.

1. (*a*) A fuel is any substance which releases heat economically and without producing any harmful or inconvenient substances upon burning.

(*b*) Because when burnt in air, sulphur produces highly obnoxious and corrosive sulphur dioxide : $S + O_2 \longrightarrow SO_2$. Secondly, it is not cheap for use as fuel.

2. (*a*) By calorific value of a fuel is meant the quantity of heat which a given mass of the fuel will produce on complete combustion.

(*b*) This statement means that one kilogram of coal gas will produce on complete combustion 4·5 kilocalories of heat.

3. (a) Coal is a solid black material consisting mainly of carbon and carbon compounds. It occurs in large underground deposits.

(b) Coal was formed by the decomposition (carbonization) of vegetable matter underground in the presence of moisture but absence of air during periods of many millions of years.

(c) Peat, lignite, bituminous coal, and anthracite. (d) Bituminous coal.

4. Because owing to the presence of very small amounts of volatile matter, anthracite is difficult to burn in ordinary stoves.

5. (a) (i) Destructive distillation means heating a complex substance in the absence of air and distilling off the volatile substances produced.

(ii) A : Ammoniacal liquor ; B : Coal tar ; C : Coal gas.

(iii) Name : Coke. Uses : (i) As a smokeless fuel ; (ii) As a reducing agent for producing metals from their oxides. (iii) In the production of water gas.

(b) Liquid A is a solution of ammonia in water and is alkaline in nature.

(c) 1. Ammonia, 2. Coal tar, 3. Coal gas, 4. Coke.

(d) 1. Carbon monoxide, 2. Hydrogen.

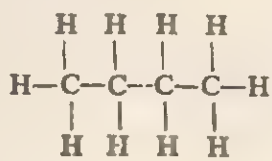
(e) Because coal gas contains 8—10 per cent of carbon monoxide which is a highly poisonous gas.

6. (a) Petroleum is a mutual solution of a large number of gaseous, liquid, and solid hydrocarbons. (b) Fractional distillation. (c) *Petrol* : As motor oil. *Kerosene* : As domestic fuel and illuminant. *Fuel oil* : As fuel in oil furnaces.

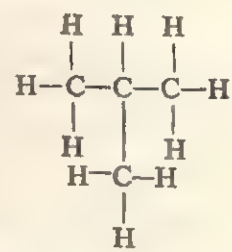
(d) Natural gas is mainly methane, CH_4, issuing from the earth near petroleum deposits.
(e) It is used as a gaseous fuel, either alone or mixed with coal gas.

7. (a) Hydrocarbons are compounds containing only carbon and hydrogen.
(b) Isomers. (c) Isomerism.

(d) Butane :



Isobutane :



8. (a) Liquified petroleum gas. (b) Liquified butane and isobutane,

(c) Because in the liquid state the gases occupy a far smaller volume and can be conveniently stored and transported in cylinders under pressure.

(d) The pressure is released and the liquefied gases are released as gases. (e) Petroleum.

9. (a) Carbon monoxide and nitrogen. (b) By blowing a limited supply of air through a a bed of burning coals. (c) Because of the presence of nearly twice the volume of non-combustible nitrogen. (d) This is done to utilize the additional heat of the gas as it leaves the producer.

10. (a) Carbon monoxide and hydrogen in the proportion 1 : 1 by volume.

(b) By alternately passing steam and air through a bed of white-hot coke.

(c) By adding butane or propane.

(d) (i) Hydrogen, (ii) $(CO + H_2) + H_2O \longrightarrow CO_2 + 2H_2$

(e) Copper oxide will be reduced to copper :

$$CuO + CO \longrightarrow Cu + CO_2 ; \quad CuO + H_2 \longrightarrow Cu + H_2O.$$

11. Both the constituents of water gas, viz., carbon monoxide and hydrogen are combustible and burn exothermically. Producer gas has only one combustible constituent, viz.,

carbon monoxide mixed with more than twice the volume of the non-combustible nitrogen.

12. (a) 1. Carbon dioxide. 2. Water

(b) Kerosene and Indane contain hydrocarbons, *i.e.*, compounds containing carbon and hydrogen only. When burnt, the carbon of the hydrocarbons produces carbon dioxide and the hydrogen produces water. Coal gas contain carbon monoxide and hydrogen which burn in air to give carbon dioxide and water respectively.

13. Burning of fuels involves exothermic oxidation of their combustible components, viz., carbon, hydrogen, and carbon monoxide.

$$C + O_2 \longrightarrow CO_2 + \text{heat} ; \quad 2H_2 + O_2 \longrightarrow 2H_2O + \text{heat} ;$$
$$2CO_2 + O_2 \longrightarrow 2CO_2 + \text{heat}.$$

14. (1) less, (2) anthracite, (3) bituminous coal, (4) does not contain, (5) hydrogen (9) LPG, (7) less.

Chapter 17.

1. (a) Under diffused sunlight. (b) $H_2 + Cl_2 \longrightarrow 2HCl$

2. (a) By heating sodium chloride with concentrated sulphuric acid.

(b) $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl\uparrow$

(c) By passing through concentrated sulphuric acid.

(d) Moist hydrogen chloride reacts both with quicklime and phosphorus pentoxide.
$CaO + 2HCl \longrightarrow CaCl_2 + H_2O$; $2P_2O_5 + 3HCl \longrightarrow POCl_3 + 3HPO_3$.

3. (*i*) Dense white fumes of ammonium chloride are formed : $NH_3 + HCl \longrightarrow NH_4Cl$.

(*ii*) A white precipitate of silver nitrate is formed :

$$AgNO_3 + HCl \longrightarrow AgCl\downarrow + HNO_3.$$

4. (a) (*i*) *A* : sodium chloride ; *B* : concentrated sulphuric acid ; *C* : Thistle funnel.

(*ii*) Hydrogen chloride being highly soluble in water dissolves in it faster than it is produced. This produces partial vacuum inside the delivery tube causing water to be sucked backward into the flask. The funnel is attached to prevent the *back suction* of water.

(*iii*) A solution of hydrogen chloride in water containing 22·2 per cent of the gas boils without any change in composition.

(*iv*) A constant boiling mixture is a solution that boils constantly without any change in the composition. That is, the composition of the solution is the same as that of the vapour produced.

(*v*) 36 per cent.

(b) (*i*) Pale-green chlorine gas is evolved :

$$MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2\uparrow.$$

(*ii*) A white precipitate of lead chloride is formed :

$$Pb(NO_3)_2 + 2HCl \longrightarrow PbCl_2\downarrow + 2HNO_3.$$

(c) (*i*) Copper (II) oxide, CuO, (*ii*) Copper (II) chloride, $CuCl_2$.

5. (a) (*i*) By heating concentrated hydrochloric acid with manganese dioxide :

$$MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2\uparrow$$

(*ii*) By adding hydrochloric acid to a solution of lead (II) nitrate :

$$Pb(NO_3)_2 + 2HCl \longrightarrow PbCl_2\downarrow + 2HNO_3.$$

(*iii*) By passing ammonia through hydrochloric acid : $NH_3 + HCl \longrightarrow NH_4Cl$.

(b) (*i*) The solution is added to sodium bicarbonate. A brisk effervescence takes place owing to the evolution of carbon dioxide :

$$NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2.$$

(*ii*) The solution is added to silver nitrate solution. A white precipitate of silver chloride is formed which is insoluble in concentrated nitric acid, but is readily soluble in ammonium hydroxide : $AgNO_3 + HCl \longrightarrow AgCl\downarrow + HNO_3$.

6. (*a*) **Aqua regia** is a mixture of 3 parts of concentrated hydrochloric acid and one part of concentrated nitric acid.

(*b*) Aqua regia is used for dissolving gold, platinum, etc.

(*c*) $HNO_3 + 3HCl \longrightarrow NOCl + 2H_2O + 2Cl$; $Au + 3Cl \longrightarrow AuCl_3$.

7. Hydrogen chloride is a covalent compound consisting of HCl molecule and no H^+ ions. Hence, it does not affect blue litmus. In solution, it ionizes to give H^+ and Cl^- ions and turns blue litmus red due to the presence of H^+ ions.

$$HCl \overset{water}{\rightleftharpoons} H^+ + Cl^-$$

8. (*a*) (*i*) $MnO_2 + 4HCl \longrightarrow MnO_2 + 2H_2O + Cl_2\uparrow$

(*ii*) $2KMnO_4 + 16HCl \longrightarrow 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2\uparrow$

(*iii*) $CaOCl_2 + 2HCl \longrightarrow CaCl_2 + H_2O + Cl_2\uparrow$

(*b*) Potassium permanganate and bleaching powder.

9. (*a*) (*i*) To prevent the chlorine produced from escaping through the thistle funnel.

(*ii*) To dissolve out any accompanying hydrogen chloride.

(*iii*) To remove the moisture and dry the gas.

(*iv*) Because it is heavier than air.

(*b*) Manganese (IV) oxide plays the part of an oxidizing agent.

(*c*) Lead (IV) oxide, PbO_2.

10. (*a*) (*i*) By dropping concentrated hydrochloric acid on potassium permanganate.

(*ii*) By heating concentrated hydrochloric acid with manganese (IV) oxide.

(*b*) Chlorine displaces iodine from potassium iodide; the iodine produces blue colour with starch.

(*c*) Chlorine sets free nascent oxygen from water. The nascent oxygen oxidizes the colouring matter into colourless matter. Hence, the material to be bleached must be moist and not dry.

11. (*i*) $Cu + Cl_2 \longrightarrow CuCl_2$; (*ii*) $2P + 3Cl_2 \longrightarrow 2PCl_3$; $2P + 5Cl_2 \longrightarrow 2PCl_5$;

(*iii*) $H_2S + Cl_2 \longrightarrow 2HCl + S\downarrow$; (*iv*) $2NaOH + Cl_2 \longrightarrow NaCl + NaClO + H_2O$;

(*v*) $6NaOH + 3Cl_2 \longrightarrow 5NaCl + NaClO_3 + 3H_2O$;

(*vi*) $2KBr + Cl_2 \longrightarrow 2KCl + Br_2$; (*vii*) $2FeCl_2 + Cl_2 \longrightarrow 2FeCl_3$;

(*viii*) $Ca(OH)_2 + Cl_2 \longrightarrow CaOCl_2 + H_2O$.

12. (*a*) Oxygen, (*b*) It will turn blue litmus red,

(*c*) (*i*) $Cl_2 + H_2O \longrightarrow HCl + HClO$, (*ii*) $2Cl_2 + 2H_2O \longrightarrow 4HCl + O_2\uparrow$

13. (*a*) Free carbon and hydrogen chloride, (*b*) $C_{10}H_{16} + 8Cl_2 \longrightarrow 10C + 16HCl$,

(*c*) Chlorine has great affinity for hydrogen.

(*d*) 1. For the extraction of gold and platinum from ores.
2. For the manufacture of poisonous gases, *e.g.*, phosgene.
3. For making chlorine containing compounds, *e.g.*, bleaching powder, chloroform etc.

14. (*a*) By allowing some slaked lime to remain in contact with chlorine inside a covered jar and passing more chlorine when the colour fades.

(*b*) By treating bleaching powder with excess of a dilute acid.

(*c*) $CaOCl_2 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + Cl_2\uparrow$

(*d*) By treating bleaching powder with a little cobalt chloride.

(*e*) $2CaOCl_2 \xrightarrow{COCl_2} 2CaCl_2 + O_2\uparrow$

(*f*) In the presence of acids bleaching powder rapidly loses all the chlorine which is a highly poisonous gas.

15. (1) a covalent (2) hydrogen chloride does not ionise in toluene (3) chlorine (4) hydrogen (5) iodide (6) blue (7) strong oxidizing action (8) slaked lime

Chapter 18.

1. (*a*) (*i*) By passing air through potassium hydroxide solution to remove carbon dioxide and then over heated copper gauze to remove oxygen, and collecting the nitrogen over water.

(*ii*) By heating ammonium nitrite or ammonium dichromate.

(*iii*) $NH_4NO_2 \xrightarrow{\Delta} N_2\uparrow + 2H_2O$; $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2\uparrow + 2H_2O + Cr_2O_3$

(*b*) The nitrogen obtained from air contains about 1% of inert gases ; the nitrogen obtained from ammonium compounds does not contain inert gases.

2. (*i*) By passing ammonia over red-hot copper oxide :

$$2NH_3 + 3CuO \longrightarrow 3Cu + 3H_2O + N_2\uparrow$$

(*ii*) By exploding ammonia with oxygen :

$$4NH_3 + 3O_2 \longrightarrow 6H_2O + 2N_2\uparrow$$

3. (*a*) Magnesium, calcium, and aluminium. (*b*) Nitrides.

(*c*) A metal nitride, *e.g.*, magnesium nitride, reacts with water to give the metal hydroxide and ammonia : $Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3\uparrow$

4. (*a*) : N :: N : (*b*) A burning magnesium wire is introduced in the gas. If the gas is nitrogen, the wire will continue to burn and the resulting ash (it is magnesium nitride) will give out the smell of ammonia when treated with water.

(*c*) (*i*) For providing inert atmosphere in chemical and metallurgical processes.

(*ii*) In the manufacture of ammonia, nitric acid, and calcium cyanamide.

5. The bacterial decomposition of nitrogen containing matter in the manure heaps produces ammonia.

6. (*a*) By heating an ammonium salt, *e.g.*, ammonium chloride with slaked lime.

(*b*) $2NH_4Cl + Ca(OH)_2 \xrightarrow{\Delta} CaCl_2 + 2H_2O + 2NH_3$

(*c*) By passing ammonia through quicklime.

(*d*) Ammonia reacts with all of these three substances. With sulphuric acid, it reacts to give ammonium sulphate : $2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$. With anhydrous calcium chloride it forms addition compounds such as $CaCl_2.4NH_3$, $CaCl_2.8NH_3$, etc. With phosphorus pentoxide its forms ammonium metaphosphate, NH_4PO_3 :

$$P_2O_5 \xrightarrow[\text{(moisture)}]{H_2O} 2HPO_3 \xrightarrow{2NH_3} 2NH_4PO_3.$$

(*e*) Ammonia is collected in gas jars by the downward displacement of air since ammonia is lighter than air.

7. (*a*) $AlN + 3H_2O \longrightarrow Al(OH)_3 + NH_3\uparrow$

(*b*) (*i*) Ammonium hydroxide : $NH_3 + H_2O \longrightarrow NH_4OH$

(*ii*) Copper metal, water (vapour), and nitrogen :

$$3CuO + 2NH_3 \longrightarrow 3Cu + 3H_2O + N_2\uparrow$$

(*iii*) Iron (III) hydroxide and ammonium chloride :

$$FeCl_3 + 3H_2O + 3NH_3 \longrightarrow Fe(OH)_3\downarrow + 3NH_4Cl.$$

(*c*) 1. In the manufacture of nitrogeneous fertilizers such as ammonium sulphate and ammonium phosphate.

2. In the manufucture of sodium carbonate by Solvay's process.

(*d*) Ammonia-water solution is used for cleaning windows, porcelain tiles, etc.

8. (*a*) Haber's process.

(b) Nitrogen is obtained by the fractional distillation of liquid air and hydrogen from water gas (Bosch Process).

(c) $N_2 + 3H_2 \rightleftharpoons 2NH_3 + 21{,}880$ cal.

(d) Nitrogen and hydrogen are mixed in the ratio 1 : 3 by volume. This ratio is used because 1 mole of nitrogen combines with 3 moles of hydrogen, and moles correspond to volumes (Avogadro's Law).

(e) 1. High pressure (200—1000 atm), 2. Temperature around 500°C, 3. Use of a catalyst.

(f) Either finely divided iron with molybdenum as promotor, or, iron oxide, Fe_3O_4, mixed with potassium oxide, K_2O, and aluminium oxide, Al_2O_3, as promoters.

(g) Because the impurities, especially carbon monoxide, cause the catalyst to become ineffective.

(h) Ammonia is separated by liquefaction ; nitrogen and hydrogen do not liquefy under the conditions employed.

9. (a) Ammonium sulphate, a nitrogeneous fertilizer, can be prepared by absorbing ammonia in sulphuric acid. The solution on evaporation and crystallization yields solid ammonium sulphate : $2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$.

(b) Ammonia is passed over heated copper oxide which oxidizes it to nitrogen :

$$3CuO + 2NH_3 \longrightarrow 3Cu + 3H_2O + N_2\uparrow$$

10. (a) The products are nitrogen and water : $4NH_3 + 3O_2 \longrightarrow 2N_2 + 6H_2O$.

(b) The products are nitric oxide and water : $4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$.

(c) H_2O, NH_4OH, NH_4^+, OH^-.

11. (a) Water, (b) Nitrogen, (c) Copper metal,

(d) $2NH_3 + 3Cu \longrightarrow 3CuO + 3H_2O + N_2\uparrow$ (e) Ammonia has been oxidized to nitrogen. (f) Copper oxide has been reduced to copper. (g) Oxidizing agent : copper oxide ; Reducing agent : Ammonia.

12. (a) X is ammonia because it is a colourless, sharp-smelling gas which yields alkaline solution in water. (b) Ammonium hydroxide, NH_4OH. (c) Y is ammonium chloride : $NH_3 + HCl \longrightarrow NH_4Cl$.

13. (a) The solution of ammonia in water contains hydroxide ions, OH^-. These ions turn red litmus blue and combine with the Fe^{3+} ions from iron (III) chloride to form a brown precipitate of iron (III) hydroxide, $Fe(OH)_3$.

(b) First a light blue precipitate of copper hydroxide, $Cu(OH)_2$, is formed. This precipitate dissolves in excess of ammonium hydroxide to give a deep blue solution due to formation of the soluble tetrammine copper (II) sulphate.

$$CuSO_4 + 2NH_4OH \longrightarrow Cu(OH)_2 + (NH_4)_2SO_4$$
$$Cu(OH)_2 + 2NH_4OH + (NH_4)_2SO_4 \longrightarrow [Cu(NH_3)_4]SO_4 + 4H_2O$$

14. (a) (i) Ammonium sulphate, $(NH_4)_2SO_4$ (ii) Ammonium nitrite, NH_4NO_2. (iii) Ammonium nitrate, NH_4NO_3.

(b) 1. $NH_4NO_2 \xrightarrow{\Delta} N_2\uparrow + 2H_2O$. 2. $NH_4NO_3 \xrightarrow{\Delta} N_2O\uparrow + 2H_2O$

15. In the reaction between ammonia and chlorine, ammonia is oxidized by chlorine to nitrogen ; chlorine is reduced to hydrogen chloride : $2NH_3 + 3Cl_2 \longrightarrow N_2 + 6HCl$. The hydrogen chloride formed combines with unreacted ammonia to form ammonium chloride : $NH_3 + HCl \longrightarrow NH_4Cl$.

The overall equation is derived as follows :

$$\begin{array}{l} 2NH_3 + 3Cl_2 \longrightarrow N_2 + 6HCl \\ \underline{NH_3 + HCl \longrightarrow NH_4Cl \quad]\times 6} \\ 8NH_3 + 3Cl_2 \longrightarrow 6NH_4Cl + N_2 \end{array}$$

16. (1) Three covalent (2) Calcium cyanamide, $CaCN_2$, (3) magnesium hydroxide, ammonia, (4) quicklime (5) high low (6) reduces, (7) Nessler's

Chapter 19.

1 (*a*) A mixture of sodium nitrate (salt of nitric acid) and concentrated sulphuric acid is distilled in a retort at 200°C. The more volatile nitric acid is displaced as a vapour which is condensed in a cooled receiver.

(*b*) $NaO_3 + H_2SO_4 \longrightarrow NaHSO_4 + HNO_3\uparrow$ (*c*) concentrated.

(*d*) The brown colour is due to the dissolved oxides of nitrogen. These oxides are produced by the decomposition of some of the nitric acid by heat.

(*e*) By bubbling air or carbon dioxide through warm acid whereby the oxides of nitrogen are swept out.

2. (*a*) Nitric oxide (*b*) Oxygen of the air (*c*) Mixture of ammonia and air (1 : 10 by volume) is heated to 800°C and passed over platinum gauze catalyst.

(*d*) Nitric oxide is mixed with more air when it is oxidized to nitrogen dioxide ($2NO + O_2 \longrightarrow 2NO_2$). Nitrogen dioxide is absorbed in water to produce nitric acid ($3NO_2 + H_2O \longrightarrow 2HNO_3 + NO$).

3. (*a*) (*i*) 1. It liberates carbon dioxide from carbonates.

$$(Na_2CO_3 + 2HNO_3 \longrightarrow 2NaNO_3 + H_2O + CO_2\uparrow)$$

2. It neutralizes alkalis to form nitrate salts and water :

$$(HNO_3 + NaOH \longrightarrow NaNO_3 + H_2O)$$

(*ii*) 1. It oxidizes carbon to carbon dioxide :

$$C + 4HNO_3 \longrightarrow CO_2\uparrow + 4NO_2 + 2H_2O$$

2. It oxidizes hydrogen sulphide to sulphur :

$$3H_2S + 2HNO_3 \longrightarrow 3S + 4H_2O + 2NO.$$

(*b*) In reaction : 1. Oxygen is added to carbon whereby it is changed to carbon dioxide.
In reaction : 2. Hydrogen is removed from hydrogen sulphide to separate sulphur.

(*c*) Dilute hydrochloric acid reacts with zinc liberating hydrogen :

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

With dilute nitric acid, hydrogen is not liberated ; instead, nitric oxide is formed :

$$3Cu + 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 4H_2O + 2NO\uparrow$$

(*d*) Concentrated nitric acid produces yellow stain on skin. This is due to the formation of a yellow compound, xanthoproteic acid, by the action of nitric acid on the protein of the skin.

4. (*i*) $S + 6HNO_3 \longrightarrow H_2SO_4 + 2H_2O + 6NO_2,$

(*ii*) $3SO_2 + 2HNO_3 + 2H_2O \longrightarrow 3H_2SO_4 + 2NO$

(*iii*) $3HCl + HNO_3 \longrightarrow Cl_2 + NOCl + 2H_2O$

5. (*a*) Copper nitrate is formed in both cases. However, with dilute nitric acid nitric oxide is formed and with concentrated nitric acid nitrogen dioxide is formed.

$$3Cu + 8HNO_3\ (\text{dil.}) \longrightarrow 3Cu(NO_3)_2 + 4H_2O + 2NO\uparrow$$

$$Cu + 4HNO_3\ (\text{conc.}) \longrightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2\uparrow$$

6. (*a*) Pure concentrated nitric acid renders iron passive. This means that the nitric acid cannot further act on iron. This is because nitric acid oxidizes the iron on the surface producing a protective film of its oxide.

(*b*) Dilute nitric acid reacts with iron to form iron (II) nitrate and nitric oxide :

$$3Fe + 8HNO_3 \longrightarrow 3Fe(NO_3)_2 + 4H_2O + 2NO.$$

7. (1) Nitric acid is used in chemical industry for the manufacture of nitrates of metals, nitrocellulose plastics, explosives, dyes, perfumes, drug etc.

(2) Nitric acid is used in the purification of silver and gold.

8. (*i*) By adding dilute nitric acid to magnesium : $Mg + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2\uparrow$.

(*ii*) By heating concentrated nitric acid with copper and passing the nitrogen dioxide evolved over red-hot iron filings : $Cu + 4\,HNO_3 \longrightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$; $6NO_2 + 8Fe \longrightarrow 4Fe_2O_3 + 3N_2\uparrow$

(*iii*) By strongly heating concentrated nitric acid and passing the gaseous mixture formed (H_2O, NO_2, and O_2) through freezing mixture ; H_2O and NO_2 are condensed while oxygen passes out : $4HNO_3 \xrightarrow{\Delta} 2H_2O\uparrow + 4NO_2\uparrow + O_2\uparrow$

9. A reddish-brown heavy gas (NO_2) is evolved and the blue crystals of copper (II) nitrate change to a black powder of copper (II) oxide :

$$2Cu(NO_3)_2 \xrightarrow{\Delta} 2CuO + 4NO_2\uparrow + O_2\uparrow.$$

10. (1) L : Dinitrogen tetroxide, N_2O_4 ; G : Oxygen, (2) lead oxide, PbO,

(3) $2Pb(NO_3)_2 \longrightarrow 2PbO + 4NO_2 + O_2$.

(4) The brown gas passing out is nitrogen dioxide mixed with oxygen. It reacts with water to form nitric acid. Industrial importance of this reaction is that it is used for the manufacture of nitric acid : $4NO_2 + O_2 + 2H_2O \longrightarrow 4HNO_3$.

(5) Lead nitrate is anhydrous ; copper nitrate is hydrated. Hence, when copper nitrate is heated, water vapour is also evolved and it condenses along with nitrogen dioxide. Sodium nitrate ; $2NaNO_3 \longrightarrow 2NaNO_2 + O_2$.

11. (*a*) By 'nitrogen cycle' is meant the circulation of nitrogen through the atmosphere, soil, and the various organisms to which nitrogen is essential.

(*b*) During lightning discharges in air, the nitrogen and oxygen present in it combine to form nitric oxide, NO. The nitric oxide combines with more of oxygen of air to form nitrogen dioxide which dissolves in water, in the presence of oxygen, to form nitric acid. The nitric acid comes down with rain to the soil where it reacts with minerals, *e g*., limestone to form nitrates :

$N_2 + O_2 \longrightarrow 2NO$; $?NO + O_2 \longrightarrow 2NO_2$; $4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$.

(*c*) The nitrates present in the soil dissolve in soil water and the solution is sucked by the plants through their roots. This removes nitrogen from soil.

12. (*a*) 'Fixation of nitrogen' means converting the free nitrogen of air into nitrogen compounds. (*b*) To make up the deficiency of these compounds which are the food of the plants.

(*c*) Any ammonium salt, *e.g.*, ammonium sulphate or ammonium nitrate. The reason is that in the presence of lime and soil water, the ammonium salt will rapidly lose its ammonia : $(NH_4)_2SO_4 + CaO \longrightarrow 2NH_3\uparrow + CaSO_4 + H_2O$.

13. (*a*) By the combined action of ammonia and carbon dioxide on powdered gypsum (calcium sulphate) suspended in water.

$$2NH_3 + H_2O + CaSO_4 + CO_2 \longrightarrow (NH_4)_2SO_4 + CaCO_3\downarrow$$

(*b*) Nitrolim is a mixture of calcium cyanamide and carbon, used as nitrogenous fertilizer. It is made by heating a mixture of lime and coal in a current of nitrogen at 1000°C : $CaO + 3C \longrightarrow CaC_2 + CO$; $CaC_2 + N_2 \longrightarrow CaCN_2 + C$.

14. (1) nitrogen dioxide. (2) nitric acid. (3) carbon dioxide, water (4) hydrogen. (5) nitric oxide nitrogen dioxide (6) Iron (7) silver metal (8) urea, ammonia carbon dioxide.

Chapter 20.

1. Three concentric pipes are sunk down to the level of the sulphur deposit. Water superheated under 10 atm pressure to 170°C is forced down the outermost pipe to melt the sulphur. Hot compressed air is forced down the innermost pipe which forces out the froth of molten air, hot water, and air through the middle pipe.

2. (*a*) Transition temperature between the two forms. (*b*) Rhombic sulphur. (*c*) Plastic sulphur. (*d*) In the manufacture of sulphuric acid and for vulcanising of rubber.

3. (*a*) Concentrated sulphuric acid. (*b*) Copper turnings,

(*c*) $Cu + 2H_2SO_4 \longrightarrow CuSO_4 + 2H_2O + SO_2\uparrow$

(*b*) By the action of sulphuric acid or hydrochloric acid on sodium hydrogen sulphite :

$$NaHSO_3 + HCl \longrightarrow NaCl + H_2O + SO_2\uparrow$$

(*c*) The term means that sulphur dioxide is sulphurous acid without water ($H_2SO_3 - H_2O = SO_2$). That is, sulphur dioxide combines with water to give sulphurous acid.

(*d*) Sulphur dioxide combines with chlorine in sunlight to give sulphuryl chloride, SO_2Cl_2.

(*e*) It turns acidified potassium dichromate solution green.

4. (*a*) (*i*) Magnesium continues to burn. Products are magnesium oxide and sulphur. $2Mg + SO_2 \longrightarrow 2MgO + S$. (*ii*) As an oxidizing agent.

(*b*) (*i*) $2Mg + SO_2 \longrightarrow 2MgO + S$, (*ii*) $SO_2 + Cl_2 + 2H_2O \longrightarrow 2HCl + H_2SO_4$

(*iii*) $2NaOH + SO_2 \longrightarrow Na_2SO_3 + H_2O$.

(*c*) In the presence of moisture. sulphur dioxide liberates nascent hydrogen which combines with the animal and vegetable colouring matter into colourless substances.

$$SO_2 + 2H_2O \longrightarrow H_2SO_4 + 2H.$$

(*d*) Water rises upward in the jar. This happens as sulphur dioxide is fairly soluble in water. Sulphurous acid is formed : $H_2O + SO_2 \longrightarrow H_2SO_3$.

5. (*a*)

Chlorine	*Sulphur dioxide*
1. Bleaches by oxidizing colouring matter.	1. Bleaches by reducing colouring matter.
2. Bleaching is permanent.	2. Bleaching is temporary.
3. Used for bleaching wood, pulp, etc.	3. Used for bleaching silk, wool, etc.

(*b*) Chlorine bleaches by oxidation ; the oxidized colourless product remains unaffected in air. Sulphur dioxide bleaches by reduction ; the reduced colourless product is oxidized by atmospheric oxygen to original coloured matter.

(*c*) 1. For making sulphuric acid, sulphites, and hydrogen sulphites.
2. For refining and decolorizing sugar.

6. (*a*) The two gases combine in the presence of platinized asbestos as catalyst :

$$2SO_2 + O_2 \longrightarrow 2SO_3$$

(*b*) (*i*) Calcium sulphate is formed : $CaO + SO_3 \longrightarrow CaSO_4$

(*ii*) Pyrosulphuric acid is formed : $H_2SO_4 + SO_3 \longrightarrow H_2S_2O_7$.

7. (*a*) Sulphur dioxide is made by burning pure Louisiana sulphur in purified air: $S + O_2 \rightarrow SO_2$. Sulphur dioxide is mixed with air and passed over heated catalyst (platinum or vanadium pentoxide) at 450°C when sulphur trioxide is formed : $2SO_2 + O_2 \longrightarrow 2SO_3$. Sulphur trioxide is dissolved in concentrated sulphuric acid when pyrosulphuric, acid, $H_2S_2O_7$, is formed : $H_2SO_4 + SO_3 \longrightarrow H_2S_2O_7$. It is diluted with water to produce sulphuric acid of any desired concentration : $H_2S_2O_7 + H_2O \longrightarrow 2H_2SO_4$.

(*b*) Favourable conditions for the oxidation of sulphur dioxide are : temperature of 400–500°C, and platinum or vanadium pentoxide as catalyst.

(*c*) The combination of sulphur dioxide and oxygen is exothermic. It releases enough heat to maintain the temperature of the catalyst. (*d*) Nitrogen dioxide, NO_2.

(*e*) $2SO_2 + 2H_2O + O_2 + [NO_2] \longrightarrow 2H_2SO_4 + [NO_2]$.

(*f*) In the manufacture of ammonium sulphate, a fertilizer.

8. (*a*) Concentrated sulphuric acid.

(*b*) Solution turns blue litmus red and produces brisk effervescence with sodium carbonate.

(c) Solution gives a white precipitate ($BaSO_4$) with barium chloride solution :

$$BaCl_2 + H_2SO_4 \longrightarrow BaSO_4\downarrow + 2HCl$$

9. Sulphuric acid is a covalent compound and does not contain H^+ and SO_4^{2-} ions. When dissolved in water to make dilute sulphuric acid, it ionizes to give these ions. Hence, dilute sulphuric acid liberates hydrogen by the action of zinc : $Zn + 2H^+ \rightarrow Zn^{2+} + H_2\uparrow$, whereas concentrated sulphuric does not. Concentrated sulphuric acid, at higher temperatures acts as an oxidizing agent and is itself reduced to sulphur dioxide.

$$H_2SO_4 \longrightarrow H_2O + SO_2 + O$$

This explains the second fact.*

10. (1) $Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$; acid dilute, in cold.
$Mg + 2H_2SO_4 \longrightarrow MgSO_4 + 2H_2O + SO_2$; acid concentrated, on heating
(2) $C + 2H_2SO_4 \longrightarrow 2H_2O + 2SO_2 + CO_2$; acid concentrated, on heating
(3) $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl\uparrow$; acid concentrated, on heating
$2NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2HCl\uparrow$; acid concentrated, strong heating
(4) $CaOCl_2 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + Cl_2\uparrow$; acid dilute, in cold
(5) $FeS + H_2SO_4 \longrightarrow FeSO_4 + H_2S\uparrow$; acid dilute, in cold
(6) $C_{12}H_{22}O_{11} + [H_2SO_4] \longrightarrow 12C + 11H_2O + [H_2SO_4]$, acid concentrated, in cold
(7) $KNO_3 + H_2SO_4 \longrightarrow KHSO_4 + HNO_3\uparrow$; acid concentrated, on heating

11. (1) High acidic strength and high boiling point : $H_2SO_4 + NaCl \longrightarrow NaHSO_4 + HCl\uparrow$
(2) Ionizes in solution to give H+ ions; $Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2\uparrow$
(3) Dehydrating agent ; $H.COOH + [H_2SO_4] \longrightarrow [H_2SO_4 + H_2O] + CO\uparrow$
(4) Oxidizing agent ; $Cu + 2H_2SO_4 \longrightarrow CuSO_4 + 2H_2O + SO_2\uparrow$

12. (1) The blue crystals of blue vitriol, $CuSO_4.5H_2O$, turn into a white powder as their water of hydration is removed by conc. sulphuric acid :

$$CuSO_4.5H_2O + H_2SO_4 \longrightarrow CuSO_4 + [H_2SO_4 + 5H_2O]$$

(2) The sugar is converted to a fluffy mass of carbon as its water is removed by concentrated sulphuric acid and converted into steam :

$$C_{12}H_{22}O_{11} + H_2SO_4 \longrightarrow 11C + [H_2SO_4 + 11H_2O]$$

13. (a) (1) E (2) C (3) B (4) A (5) D.

(b) In the manufacture of fertilizers (*e.g.*, ammonium sulphate and superphosphate of lime) ; in the manufacture of hydrochloric acid, nitric acid, and metal sulphates ; and in lead storage batteries.

14. (1) physical (2) eight membered rings (3) rhombic (4) oxidized (5) reduction (6) two (7) strong dehydrating agent (8) oxalic acid.

Chapter 21.

1. (a) Metals tend to form positive ions by loss of electrons ; non-metals tend to form negative ions by gain of electrons.

(b) (*i*) Most metals liberate hydrogen from acids; non-metals do not liberate hydrogen from acids. (*ii*) Metals are good reducing agents; non-metals are good oxidizing agents. (*iii*) Metals usually form basic oxides; non-metals usually form acidic oxides. (*iv*) Metals do not form stable hydrides; non-metals form stable hydrides.

(c) (*i*) Gold, (*ii*) Zinc, (*iii*) Aluminium.

*This may be appreciated from the following partial equations :

$$\begin{aligned} H_2SO_4 &\longrightarrow H_2O + SO_2 + O \\ Zn + O &\longrightarrow ZnO \\ ZnO + H_2SO_4 &\longrightarrow ZnSO_4 + H_2O \\ \hline Zn + 2H_2SO_4 &\longrightarrow ZnSO_4 + 2H_2O + SO_2 \end{aligned}$$

2. (a)

Metal	Ore Name	Formula	Method of extraction from ore
1. Iron	Haematite	Fe_2O_3	Reduction with carbon
2. Zinc	Zinc blende	ZnS	Roasting followed by reduction with carbon
3. Aluminium	Bauxite	$Al_2O_3.2H_2O$	Electrolysis

(b) $PbO + C \longrightarrow Pb + CO$

3. (a) Haematite, Fe_2O_3 ; and spathic iron ore, $FeCO_3$.
(b) X is limestone, $CaCO_3$. It removes silica by first decomposing to give calcium oxide which combines with silica to form calcium silicate slag.
$$CaCO_3 \longrightarrow CaO + CO_2\uparrow ; \; CaO + SiO_2 \longrightarrow CaSiO_3$$
(c) (i) Carbon monoxide, CO ; (ii) Iron (III) oxide, Fe_2O_3
(d) In the lower part of the blast furnace carbon burns in a blast of air to produce carbon dioxide : $C + O_2 \longrightarrow CO_2$. The carbon dioxide rising through red hot coke is reduced by carbon to carbon monoxide : $CO_2 + C \longrightarrow 2CO$.

4. (i) A is carbon dioxide, B is carbon monoxide, (ii) Because B removes oxygen from ion oxide.

5. (a) Coke, limestone, and air.
(b) (i) Blast furnace,
(ii) Double cup and cone arrangement. It does not allow hot gases to escape through the hopper when the charge is being fed in the furnace.
(iii) Tuyeres,
(iv) molten slag, molten iron,
(v) Carbon monoxide, carbon dioxide, and nitrogen. It is used for burning coke to heat the air blast entering the furnace.
(vi) Calcium silicate, $CaSiO_3$
(vii) In making highways.
(viii) Pig iron contains 3-5 per cent of carbon ; steel contains 0·2 to 1·7 per cent of carbon.
(ix) It is brittle and cannot be welded.
(x) Oxygen is blown into molten pig iron till all carbon has burnt away. Then the required amount of carbon and manganese is added.

6. (a) Bauxite, $Al_2O_3.2H_2O$.
(b) By electrolysing purified bauxite dissolved in molten cryolite using copper cathode and carbon anode.
$$Al^{3+} + 3e^- \longrightarrow Al \text{ (at cathode)} ; \quad 2O^{2-} \longrightarrow O_2\uparrow + 4e^- \text{ (at anode)}$$
(c) Aluminium has great affinity for oxygen; so, its oxide is not reduced by carbon or hydrogen.
(d) 1. It is good conductor of heat and electricity. 2. It resists corrosion.

7. (a) (i) $2ZnS + 3O_2 \longrightarrow 2ZnS + 2SO_2\uparrow$ (ii) $ZnO + C \longrightarrow Zn + CO\uparrow$
(b) For galvanizing iron to protect it from corrosion, for the extraction of silver and gold, and in the manufacture of containers of dry cells.

8. (1) Zinc (2) Zinc (3) Lead (4) Iron (5) Aluminium (6) Lead (7) Aluminium, (8) Magnesium.

10.

Metal	*Use*	*Property on which the use depends*
1. Aluminium	1. Deoxidizer in steel making 2. For making mirrors for reflecting telescopes	1. Great affinity for oxygen 2. Excellent reflector of light
2. Copper	1. Making vacuum pans 2. Making electrical wiring	1. High thermal conductivity 2. High electrical conductivity
3. Lead	1. For acid-resistant lining 2. For making pipes for conveying water	1. Resistance to corrosion 2. Flexibility
4. Magnesium	1. In the extraction of titanium from titanium chloride 2. In signal flares	1. Strong reducing action 2. Produces intense white light on burning
5. Zinc	1. For galvanizing iron 2. For extraction of silver and gold	1. Strongly electropositive 2. Strongly electropositive

11. (*a*) An alloy is a metallic material containing two or more elements.

(*b*) Alloys of mercury. (*c*) Brasses, bronzes, and steels.

(*d*)

Alloy	*Constituents*		*Useful Properties*
(*i*) Brass	Copper and zinc	(*i*) Ductile	(*ii*) Easily cast
(*ii*) Bronze	Copper and tin	(*i*) Hard	(*ii*) Easily cast
(*iii*) Type metal	Lead and antimony	(*i*) Hard	(*ii*) Expands on cooling
(*iv*) Magnalium	Aluminium and magnesium	(*i*) Light	(*ii*) Resists corrosion
(*v*) Stainless steel	Iron, chromium, and carbon	(*i*) Attractive colour	(*ii*) Resists corrosion

(*e*) Duralumin and magnalium.

12. B, C, A

13. (*a*) Calcium, iron, lead.

(*b*) (*i*) Calcium liberates hydrogen from cold water, iron liberates hydrogen from steam, while lead does not liberate hydrogen even from steam.

(*ii*) Calcium oxide is not reduced, lead oxide is readily reduced, iron oxide is reduced but less readily than lead oxide.

14. (*a*) Sodium, zinc, iron, lead.

(*b* (*i*) sodium, M, zinc, iron, lead. (*ii*) By the electrolysis of its fused chloride. (*iii*) $M_2CO_3 \longrightarrow M_2O + CO_2$ (*iv*) Zinc will be displaced and M will dissolve.

$$M + ZnSO_4 \longrightarrow MSO_4 + Zn$$

15. (*i*) Ca, Mg, Al, Zn, Fe, Ag (*ii*) Silver, (*iii*) Calcium,

(*iv*) Calcium, $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2\uparrow$,

(*v*) Silver ; $2Ag_2O \longrightarrow 4Ag + O_2$, (*vi*) Zinc will dissolve displacing iron from the solution. (*vii*) Calcium.

16. (*i*) Z (*ii*) Z, (*iii*) X, (*iv*) Z, (*v*) Y can be used to displace Z from a solution of its salts. (*vi*) A film of copper metal is deposited on the surface of Y. (*vii*) X.

17. (*i*) X will combine with oxygen slowly at ordinary temperature and rapidly on heating to form its oxide. (*ii*) X will fairly rapidly decompose cold water liberating hydrogen and forming the hydroxide of X. (*iii*) X will displace hydrogen from HCl and form its chloride.

18. Y, Z, X.

Chapter 22.

1. (*a*) An acid is a substance which when dissolvedin water, yields hydronium ion, H_3O^+, as the only positive ion.

(*b*) Citric acid in lemon and tartaric acid in tamarind.

(*c*) $HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$; $HNO_3 + H_2O \longrightarrow H_3O^+ + NO_3^-$

(*d*) (*i*) By comparing the electrical conductivities of the two acids.
(*ii*) Dilute hydrochloric acid.

(*e*) First, by testing with blue litmus which is turned red. Second, by adding a little sodium hydrogen carbonate when a brisk effervescence occurs due to the evolution of carbon dioxide.

(*f*) Strong acids give a very high concentration of hydrogen ions in water solutions; weak acids give only a low concentration.

2. (*a*) The hydrogen ion exists in solution in the hydrated form. The name of hydrated hydrogen ion is hydronium ion and its formula is H_3O^+ ($H^+.H_2O$).

(*b*) The basicity of an acid is the number of hydrogen ions formed by the ionization of one molecule of it.

(*c*) $H_2SO_4 \rightleftharpoons H^+ + HSO_4^-$; $HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$

(*d*) The common properties of acids are due to the hydrogen (or, hydronium) ions they give in solution.

3. (*a*) A base is a compound which reacts with an acid to form a salt and water only.

(*b*) The oxides and hydroxides of metals.

(*c*) Sodium hydroxide, copper oxide, iron (III) hydroxide.

(*d*) Ammonium hydroxide, NH_4OH.

(*e*) An alkali is a base which dissolves in water to give hydroxyl ions, OH^-.

(*f*) Sodium hydroxide, NaOH. (*g*) Ammonium hydroxide.

(*h*) (*i*) Neutralization, (*ii*) A salt and water, (*iii*) $NaOH + HCl \longrightarrow NaCl + H_2O$.

(*i*) This means that one molecule of calcium hydroxide ionizes to give two hydroxyl ions, OH^-, in solution : $Ca(OH)_2 \rightleftharpoons Ca^{2+} + 2OH^-$.

(*j*) The common properties of alkalis are due to the hydroxyl ions, OH^-, they give in solution.

4. Solutions of strong alkalis absorb the acidic carbon dioxide from the air and are partly neutralized forming carbonates : $2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$.

5. (*a*) The pH scale is a scale for measuring the acidic and basic strengths of solutions. It runs from 1 to 14.

(*b*) The solution is neither acidic nor basic, *i.e.*, it is neutral. (*c*) Boric acid.

(*d*) Sodium hydroxide, (*e*) Litmus : Red, Blue ; Phenolphthallin : Colourless, Pink ; Methyl Orange : Yellow, Red.

6. (*a*) Neutralization is a chemical reaction in which the H^+ ions from an acid combine with the OH^- ions from the base to give molecules of water : $H^+ + OH^- \longrightarrow H_2O$. The ions associated with the H^+ ions in acid and the OH^- ions in base form a salt.

(*b*) The reaction between an acid and a base involves the combination of the H^+ ions from the acid and the OH^- ions from the base. One mole of any monobasic acid produces 1 mole of H^+ ions and one mole of any mono-acid base produces 1 mole of OH^- ions. So, the reaction between them produces the same quantity of heat.

(*c*) The heat liberated is called the 'heat of neutralization', and its value is 13·7 kcal per equivalent.

7. (*a*) A salt is a substance which in water solution yields a positive ion other than the hydrogen ion, H^+, and a negative ion other than the OH^-.

(*b*) A normal salt is formed when all ionizable hydrogen atoms in the acid are replaced by metal atoms. For example, the replacement of both ionizable hydrogen atoms in H_2SO_4 by sodium atoms gives the normal salt Na_2SO_4 (sodium sulphate). An acid salt is formed when only a part of the ionizable hydrogen atoms in the acid is replaced by metal atoms. For example, the replacement of one out of the two ionizable hydrogen atoms in H_2SO_4 by sodium atom give the acid salt $NaHSO_4$ (sodium hydrogen sulphate).

8.

Class of Substance	*Representative Substance*	*Molecular Equation*	*Ionic Equation*
1. Metal	Zinc	$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2\uparrow$	$Zn + 2H^+ \rightarrow Zn^{2+} + H_2$
2. Metal Oxide	Calcium oxide	$CaO + 2HCl \rightarrow CaCl_2 + H_2O$	$CaO + 2H^+ \rightarrow Ca^{2+} + H_2O$
3. Metal carbonate	Copper Carbonate	$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$	$CuCO_3 + 2H^+ \rightarrow Cu^{2+} + H_2O + CO_2\uparrow$

9.

Salt	*Method*	*Equation*
Anhydrous iron (III) chloride	A	$2Fe + 3Cl_2 \longrightarrow 2FeCl_3$
Sodium sulphate	D	$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$
Zinc chloride	B	$Zn + 2HCl \longrightarrow ZnCl_2 + H_2\uparrow$
Lead chloride	E	$Pb(NO_3)_2 + 2HCl \longrightarrow PbCl_2\downarrow + 2HNO_3$
Copper sulphate	C	$Cu(OH)_2 + H_2SO_4 \longrightarrow CuSO_4 + 2H_2O$

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10.

Name of salt	*Method of Preparation*	*Substances used*	*Equation*
1. Lead chloride	Double decomposition	1. Lead nitrate 2. Hydrochloric acid	$Pb(NO_3)_2 + 2HCl \longrightarrow PbCl_2 + 2HNO_3$
2. Copper (II)	Action of acid on oxide	1. Copper (II) oxide 2. Sulphuric acid	$CuO + H_2SO_4 \longrightarrow CuSO_4 + H_2O$
3. Zinc sulphate	Action of acid on metal	1. Zinc 2. Sulphuric acid	$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$
4. Sodium nitrate	Acid-base titration	1. Sodium hydroxide 2. Nitric acid	$NaOH + HNO_3 \longrightarrow NaNO_3 + H_2O$

11. (1) Some clean iron filings are placed in dilute sulphuric acid and stirred. If all iron dissolves, a little more is added until some of it remains undissolved.

(2) Excess of iron filings are removed by filtration.

(3) The filtrate is concentrated by evaporation to the 'point of crystallization', and then allowed to cool.

(4) Crystals of iron (II) sulphate, $FeSO_4.7H_2O$, are deposited. These are separated from the mother liquior by filtration and washed twice with water.

(*b*) $Fe + H_2SO_4 \longrightarrow FeSO_4 + H_2\uparrow$

12. (1) Copper (II) oxide is added, a little at a time and with stirring, to warm dilute sulphuric acid. Excess copper oxide is filtered off. The filtrate is evaporated to the 'point of crystallization', and then allowed to cool. Crystals of copper sulphate are deposited. These are separated by filtration.

(2) Lead nitrate is dissolved in water. To the solution is added hydrochloric acid until no more precipitate forms. The precipitate of lead chloride is removed by filtration, washed with water, and dried.

13. (*a*) (*i*) $2Na + Cl_2 \longrightarrow 2NaCl$ (*ii*) $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

(*iii*) $NaOH + HCl \longrightarrow NaCl + H_2O$

(*iv*) $CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3\downarrow + 2NaCl$

(*b*) The two solutions are of lead nitrate and sulphuric acid :

$$Pb(NO_3)_2 + H_2SO_4 \longrightarrow PbSO_4\downarrow + 2HNO_3.$$

14. Zinc carbonate is added, a little at a time and with stirring, to warm dilute sulphuric acid until no more effervescence occurs. Excess of zinc carbonate is removed by filtration. The filtrate is concentrated by evaporation and cooled. Crystals of zinc sulphate deposited are removed by filtration, washed, and dried.

$$ZnCO_3 + H_2SO_4 \longrightarrow ZnSO_4 + H_2O + CO_2\uparrow$$

15. (f) (c) (d) (g) (a) (e) (b)

16. (*i*) Concentrated hydrochloric acid, (*ii*) Potassium permanganate,
(*iii*) Concentrated sulphuric acid (*iv*) $2Fe + 3Cl_2 \longrightarrow 2FeCl_3$,

(v) The solid is dissolved in water and potassium ferrocyanide solution is added to it. deep blue precipitate will form showing that the compound is an iron (III) compound.

(vi) Because iron (III) chloride is to be obtained anhydrous

17. (a) Both of these salts reacts with water. Sodium carbonate reacts with water, producing a strong alkali, sodium hydroxide, and a weak acid, carbonic acid. Hence, the solution is alkaline : $Na_2CO_3 + H_2O \rightleftharpoons 2NaOH + H_2CO_3$. Ammonium chloride reacts with water to produce ammonium hydroxide, a weak alkali, and hydrochloric acid, a strong acid. Hence, the solution is acidic : $NH_4Cl + H_2O \rightleftharpoons NH_4OH + HCl$.

(b) Hydrolysis. (c) (i) Acidic solutions : ammonium sulphate ; copper sulphate.

(ii) Alkaline solutions : potassium carbonate ; sodium acetate,

(iii) Neutral solutions : potassium nitrate ; sodium chloride.

18 (i) A substance which absorbs so much water from the air that it dissolves in it forming a solution, *e.g.*, hydrated calcium chloride, $CaCl_2 . 6H_2O$.

(ii) A substance which absorbs water from air but not so much as to dissolve in it, *e.g*, phosphorus pentoxide.

(iii) A hydrated salt which loses its water of crystallization when exposed to air and changing from crystals to a powder, *e.g.*, sodium carbonate, $Na_2CO_3 . 10H_2O$.

19. (1) acetic (2) neutralization (3) acidic (4) increases (5) 7 (6) hydrolysis (7) nitrites nitrates (8) H^+, (9) OH^- (10) H^+ OH^- base, water.

□